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THE CONSTITUENTS OF LICORICE ROOT AND OF LICORICE EXTRACT. PART I.

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The literature of licorice root and extract is a voluminous one, in spite of which, our knowledge of the constituents of the root and the juice, and of methods for their quantitative examination is very incomplete; so incomplete that it is often impossible to state with certainty whether or not a sample of extract is adulterated, unless the adulteration is either gross or crudely performed.

The most valuable contributions to our knowledge of licorice have been made by Tschirch and his co-workers. Other recent authors have made, for the most part, only unimportant modifications of methods of analysis proposed by the earlier investigators,—Diehl, Habermann, Py, Hafner and others. The earlier methods of analysis for licorice extract are largely embodied in that published by Parry,[1] and received by him through the courtesy of the MacAndrews & Forbes Company, which has for more than twenty years used the method reproduced by Parry. This method has been found as satisfactory for commercial use as any other method proposed, but is capable of much improvement—chiefly in two directions.

1. The determination of the *true* glycyrrhizin instead of the so-called "crude" glycyrrhizin, which possesses varying and unknown degrees of crudeness.
2. The inclusion in the analysis, of some of the undesirable

[1] *Chemist and Druggist*, Jan., 1910.

constituents of licorice extract, notably of bitter substances and of resins, thereby lessening the item of "Extractive and coloring matter" which is at present used to make the analytical figures add up to 100.

I give a summary of the method of analysis for licorice extract now used by me, before proceeding to a discussion of the recent papers of Tschirch, Eriksson and others.

Moisture and Ash are determined in the usual manner.

Matters insoluble in cold water.—Two grams of the extract are spread on the sides of a small, copper gauze basket, which is placed in a 100 c.c. cylindrical glass tube drawn out to a conical end and containing about 75 c.c. of distilled water. The tube is closed with a rubber stopper and agitated in a shaking machine until the paste is completely disintegrated (½ hour to 1 hour) and then whirled in a Babcock centrifuge for 15 minutes at 1000 revolutions per minute. The clear liquor is poured off and the sediment stirred up with fresh water and whirled for a further 15 minutes. After pouring off the liquor, the sediment is washed into a tared glass dish, evaporated and weighed.

Most licorice pastes, when freshly made, will contain not more than 3 per cent. by weight of matters insoluble in cold water, unless made from very starchy root or from liquor which, having been partly chilled, contains gelatinized starch. A paste containing more than this amount should be dissolved without the aid of a shaking machine by suspending in cold water, as the use of the shaking machine is found to give low results with pastes containing much insoluble matter. Many experiments have shown that 15 minutes is a sufficient time to centrifuge at 1000 revolutions, the results being identical with those obtained by 24 hours settling in a tall jar.

Matters insoluble in hot water.—This estimation is carried out in a similar manner to the preceding determination, using hot water.

Starch and Gums.—Two grams of licorice mass are dissolved in 10 c.c. hot water, in a centrifuge tube similar to that used for "matters insoluble in cold water." The solution is cooled and 20 c.c. 80 per cent. alcohol (by volume) are added with stirring. Fifty c.c. 95 per cent. alcohol are then added gradually with stirring. After allowing to stand 2 hours, which time is found sufficient to

precipitate all starch and gummy matters, the contents of the tube are centrifuged. After pouring off the clear liquor, the precipitate is stirred up with 80 per cent. alcohol and centrifuged. This operation is carried out three times in all. The precipitate, consisting of starch and gums, and of the mechanical impurity in the paste, is washed into a tared dish, evaporated and weighed. The mechanical impurities (matters insoluble in hot water) are deducted, to give the true weight of starch and gums.

Glycyrrhizin.—The clear 80 per cent. alcoholic liquor, poured off from the starch and gums, is evaporated just to dryness *in vacuo* on a water bath. The residue is transferred to a small conical beaker with 30 c.c. water and after cooling to 15° C., the crude glycyrrhizin is precipitated with 3 c.c.[2] dilute sulphuric acid (10 c.c. conc. sulphuric acid to 300 c.c. water). After standing for 2 hours (12–24 hrs. as usually recommended is unnecessary and gives lower results) at a temperature of about 10° C., the contents of the beaker are cooled in ice for half an hour, and the clear supernatant liquor poured through a small filter. The glycyrrhizin is washed four times by decantation with ice water, in which it is practically insoluble. The glycyrrhizin in the beaker, together with any that may have been transferred to the paper, is dissolved in dilute alcohol. Two drops of 5 per cent. ammonia are added to neutralize traces of sulphuric acid, and the solution is transferred to a tared dish, evaporated, and the crude glycyrrhizin weighed.

Sugars.—The filtrate and washings from the glycyrrhizin, amounting to about 70 c.c., are received in a 100 c.c. graduated flask. Enough of a concentrated solution of basic lead acetate is added to precipitate both the sulphuric acid and the resins, bitter substances, coloring matters, etc. (3 c.c. are usually sufficient). The liquid is made up to 100 c.c. and filtered into a 100 c.c. graduated cylinder. The excess of lead is exactly removed with sodium carbonate, the liquid made to 100 c.c. again, filtered, and titrated with Fehling's solution before and after inversion.

The results obtained by this method agree well with those obtained by treating the solution of the original licorice mass with basic lead acetate, and it has a number of advantages over the latter procedure, amongst which is the greater convenience of manipula-

[2] Eriksson (*Arch. d. Pharm.*, 249, 1911, p. 147), in reproducing the method given in Parry's paper, gives the quantity of sulphuric acid erroneously as 30 c.c.

tion due to the previous removal of starch, gums, glycyrrhizin and other substances liable to vitiate the results.

The results for sugars obtained by Parry, especially for those before inversion, are decidedly too high, and result, in my opinion, either from using too little lead acetate or more probably from failing to remove the precipitate of lead gums, lead glycyrrhizinate, etc., before eliminating excess of lead acetate with aluminum sulphate.

If this lead precipitate, which contains practically all of the licorice except starch and sugars, is not filtered off, it is partly decomposed by aluminum sulphate, regenerating substances capable of reducing Fehling's solution and falsely reckoned as sugars. This is shown by the following example:

TABLE 1.

	Without separate filtration of lead ppt.	With separate filtration of lead ppt.
	per cent.	*per cent.*
Reducing sugars	6.6	6.3
Total sugars	11.6	9.4

The necessity of using a large amount of lead acetate, if the sugar estimation be carried out on a solution of the original paste, is shown by the following results:

TABLE 2.

	Without separate filtration of lead ppt.	With separate filtration of lead ppt.			
Vol. lead acetate—cc	....	5	10	15	20
Vol. alum. sulp. to ppt. lead in filtrate—cc	....	1	2	3	4
Reducing sugars	6.6	6.3	5.1	4.7	4.0
Total sugars	11.6	9.4	8.3	7.1	6.7

The addition of more than 20 c.c. basic lead acetate does not lower the results further. The use of such a large amount of lead acetate causes the mass to set almost solid and is so inconvenient to manipulate that I have evolved the method given above for the estimation of the sugars—*i.e.*, in the filtrate from the glycyrrhizin.

Comment may be made on some of the other items in the analytical process for licorice mass.

Matters insoluble in cold water.—This is generally supposed to contain little else but starch and mechanical impurity. In the case of extracts which have been stored some time, a considerable amount of resin or allied substance may be deposited, as well as starch. The progressive deposition of starch is shown in the results below.

TABLE 3.

Age of sample.	Insolubles cold water.	Age of sample.	Insolubles cold water.
days	*per cent.*	*days*	*per cent.*
1	1.91	19	9.50
3	2.33	26	11.98
5	4.14	34	13.90
8	5.87	40	15.24
12	6.92	92	15.88
14	7.42	224	16.00

When the extract contained 15 per cent. of matters insoluble in cold water, the matters insoluble in 2 per cent. ammonia (*i.e.*, 2 parts conc. aqueous solution of ammonia to 98 parts water) amounted to only 10 per cent.—indicating a deposition of resins or similar substances of 5 per cent. This disproves the assertion by Parry[3] that, in a pure licorice extract, the matters insoluble in dilute ammonia should not exceed 6 per cent. I have examined very many samples of pure licorice which have contained more than that amount.

The increase of "matters insoluble in cold water" with age is highly variable. A sample from liquor which had been partly enzymed, increased only 1.6 per cent. in 17 days, a further 3 per cent. in the next 17 days, and had then almost reached a maximum. In other cases the deposition of starch is rapid and attains a maximum after about three weeks.

Starch and Gums.—A number of variations of the method given above have been tried.

Variation of the strength of alcohol employed gave the following results:

[3] *Chemist & Druggist*, April 29, 1911.

TABLE 4.

Strength of alcohol by volume.	29	39	52	68	72	76	80	83	91
Per cent. starch and gums	1.7	9.8	13.6	20.2	22.4	24.4	26.2	30.6	39.7

The starch and gums precipitated by 91 per cent. alcohol contained glycyrrhizin, as evidenced by a decided sweet taste.

I have not been able, hitherto, to effect a satisfactory quantitative separation of the starch from the gummy matters, although such a separation is desirable.

Glycyrrhizin.—The following table shows that the glycyrrhizin from two grams licorice mass is completely precipitated by 1.5 c.c. of 3 per cent. (by volume) sulphuric acid.

TABLE 5.

Volume sulphuric acid—cc.	0.3	0.8	1.0	1.5	3.0	3.0	3.0
Strength sulphuric acid (by volume)	*per cent.* 3	*per cent.* 3	*per cent.* 3	*per cent.* 3	*per cent.* 3	*per cent.* 10	*per cent.* 30
Glycyrrhizin	5.6	15.3	17.4	19.0	19.1	19.5	18.6

On adding further 1.2 c.c. 3 per cent. sulphuric acid to the first test, a further 13.3 per cent. glycyrrhizin was precipitated, making 18.9 per cent. in all.

On adding further 0.7 c.c. 3 per cent. sulphuric acid to the second test, a further 4.0 per cent. glycyrrhizin was precipitated, making 19.3 per cent. in all.

Other authors have used a needless and, in the light of Tschirch's work on the hydrolysis of glycyrrhizin, probably a dangerous excess of acid, to precipitate the glycyrrhizin, *e.g.*, Telle[4] uses 1 c.c. concentrated hydrochloric acid to 50 c.c. solution, and Gouirand,[5] 1 c.c. 50 per cent. sulphuric acid to 5 c.c. of the solution.

Washing with ice water is to be preferred to washing with dilute acid.

A rough idea of the degree of purity of the crude glycyrrhizin precipitated by sulphuric acid may be obtained by re-precipitating several times, and observing the successive loss in weight and increase in sweetness.

[4] *Ann. Falsific.*, 1911, vol. iv, pp. 3–12.

[5] *Bull. de Pharm. du Sud-Est*, 1912, 86.

The loss in weight is greatest at the second precipitation, usually about 3 per cent. on original extract, while at the third and fourth precipitations, the percentage usually decreases by about 1 per cent. only. The sweetness is noticeably increased at the second precipitation, and altered but little by a third and fourth.

The following condensed analyses are cited as typical. The roots were treated in open, copper digestors provided with a steam inlet at the bottom, through which just enough steam was admitted to keep the liquor boiling. Five liquors were drawn off at intervals of 30 minutes, and the spent root finally pressed to remove adherent liquor. The liquors were evaporated in a steam-jacketed copper pan. The results are calculated to 10 per cent. root moisture and 25 per cent. moisture in the extract.

TABLE 6. ANALYSES OF LICORICE EXTRACTS.

Kind of root.	Yield of extract. Per cent.	Per cent. glycyrrhizin.	Per cent. starch and gums.	Per cent. total sugars.	Per cent. ash + extractive and coloring matter.
Russian	27.6	24.14	23.24	9.56	18.06
Syrian	26.2	19.43	18.20	19.81	17.56
Anatolian	40.6	21.96	16.37	16.89	17.56
Turk-Arabian	27.3	20.15	17.84	14.71	22.30
Italian	41.1	15.76	23.74	17.18	18.32
Spanish-Cordoba	37.7	14.32	24.08	9.37	27.23

A stronger extraction under 35 pounds' steam pressure, corresponding to 138° C., tends to lower glycyrrhizin and sugars, and to increase starch and gums. The results below are not from the same samples of roots as those in Table 6.

TABLE 7. ANALYSES OF LICORICE EXTRACTS MADE AT 35 LBS. STEAM PRESSURE.

Kind of root.	Yield of extract. Per cent.	Per cent. glycyrrhizin.	Per cent. starch and gums.	Per cent. total sugars.	Per cent. ash + extractive and coloring matter.
Russian	46.6	15.60	30.57	11.77	17.06
Syrian	41.0	14.43	30.47	11.26	18.84
Anatolian	54.0	15.41	28.63	9.36	21.60
Italian	52.0	12.47	29.84	14.70	17.99
Spanish-Cordoba	54.2	12.18	33.01	8.61	21.20

An essentially new procedure for the estimation of the most

important constituents of licorice root, is that proposed by Tschirch [6] and worked out by Eriksson.[7]

The method depends on the successive reduction of Fehling's solution by glucoses, saccharose and glycyrrhizin. It is stated that these reactions occur quantitatively in the following stages:

1. Standing for about 12 hours in the cold (glucose).
2. Boiling for 3 minutes (saccharose).
3. Boiling for 15 hours (glycyrrhizin).

Certain objections to Eriksson's procedure may be mentioned.

1. Eriksson moistens the root with water and allows it to stand for several hours, whereby enzyme action unavoidably occurs, the result of which can scarcely fail to effect one or more of the stages of the reduction of Fehling's solution.

2. It is assumed that sugars and glycyrrhizin are the only substances extracted which are capable of reducing Fehling's solution, whereas licorice root contains an abundance of resinous and bitter substances which reduce Fehling's solution, and which would be partly extracted even by the comparatively mild percolation with alkaline water which Eriksson describes. If the method is to be used for sugars, a modification is necessary, involving the previous removal of such resinous and bitter substances, by basic lead acetate or by other means.

The estimation of glycyrrhizin is also open to a similar objection, in that other substances capable of reducing Fehling's solution are associated with the glycyrrhizin.

3. The method describes the estimation of sugars by successively allowing to stand with Fehling's solution for 12 hours and filtering, followed by boiling for 3 minutes. This takes no account of such saccharine matters as cane sugar, which requires inversion with mineral acid or a suitable ferment, before being capable of reducing an alkaline copper solution.

4. When the method is applied to licorice *extract* instead of the root, another source of error becomes apparent. Eriksson calls attention to a very important fact—*viz.*, the discrepancy between the glycyrrhizin content of the root and that of the extract, indicating partial hydrolysis of glycyrrhizin in the process of extraction. Tschirch [8] also states his belief that a portion of the glycyrrhizin is

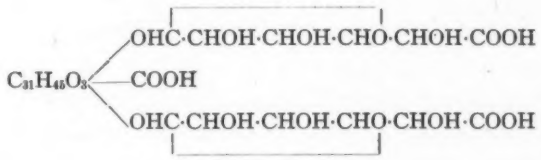
[6] Handbuch d. Pharmakog II, p. 90.
[7] *Arch. d. Pharm.*, 249 (1911), pp. 144–160.
[8] Handbuch der. Pharmakog. II, p. 101.

split up, and my own experiments (communicated below) confirm this idea. The products of such partial decomposition probably include glucuronic acid, or other substances capable of reducing Fehling's solution. According to Eriksson's method, these substances would be reckoned as sugars, which error is much less likely to occur in the method I use, in which starch, gums and glycyrrhizin have been first removed, and basic lead acetate then used to precipitate other non-sugars, including glucuronic acid.

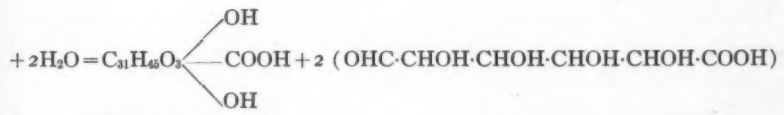
In attempting to control Eriksson's method experimentally I have been unable to obtain satisfactory results.

Experiments made on glucose and on saccharose showed that not more than three-fourths of the former was decomposed by standing with Fehling's solution for the prescribed time or longer, and that the saccharose was unaffected by 2, 3 or 5 minutes' boiling with Fehling's solution.

In a series of valuable researches, Tschirch [9] and his pupils have prepared pure glycyrrhizic acid as colorless crystals free from nitrogen. On hydrolysis it was shown to be a di-glucuronic ether of glycyrrhetic acid.



Glycyrrhizic Acid



Glycyrrhetic Acid — Glucuronic Acid

Eriksson has applied this reaction to the estimation of glycyrrhizin, by boiling for 15 hours with Fehling's solution, but I have been unable to confirm the results given, and obtained just as

[9] Tschirch & Cederberg *Arch d. Pharm.*, 1907, 245, p. 97.
Tschirch & Gauchmann *Arch d. Pharm.*, 1908, 246, p. 545.
Tschirch & Gauchmann *Arch d. Pharm.*, 1909, 247, p. 121.

much cuprous oxide from a blank experiment as from the solution which contained glycyrrhizin. It is evident that the procedure given by Eriksson for the quantitative estimation of the sweet substances of licorice root and extract is not accurate.

TREATMENT OF LICORICE ROOT WITH SOLVENTS.

The method of analysis for licorice extract which I have given at the commencement of this paper has usually been found satisfactory from a commercial standpoint. Occasionally it fails to distinguish between what are considered good and poor qualities of licorice mass. An unpalatable extract may sometimes show high values for glycyrrhizin and sugars. This discrepancy is due to the absence of quantitative estimations for such of the undesirable constituents of the extract as bitter and resinous substances. To pave the way for the elaboration of such estimations, I have commenced investigations on the root, with the idea of later transferring to the analysis of the extract, the knowledge so gained. Some of the results obtained may be communicated here.

Extraction of Licorice Root with Petroleum Ether.—Licorice root yields less than 1 per cent. of its weight to petroleum ether, and only a few roots were treated with this solvent.

Anatolian root[10] yielded 0.32 per cent. of a brown semi-solid extract, of bitter taste and unpleasant odor. On slow evaporation colorless needle-shaped crystals separated from the syrup. These are practically insoluble in petroleum ether, ether, and alcohol, but may be crystallized from warm benzene or chloroform. Further examination of these crystals is contemplated. Sodium carbonate dissolves practically nothing from the syrup, but sodium hydrate effects a partial separation.

Italian root (green) yielded 0.95 per cent. of petroleum ether extract.

Syrian root yielded 0.54 per cent., of a darker brown color than the petroleum ether extracts from the other roots.

Extraction of Licorice Root with Chloroform.—When a chloroform extract of licorice root is evaporated, a mixture of colorless

[10] Nickum (AMER. JOUR. PHARM., 1895, Vol. 67, p. 306), extracting Anatolian licorice root, obtained 0.54 per cent. extract, and also observed the separation of crystals from the syrup.

crystals with a yellow fatty substance is obtained. The latter is readily removed by ether. On crystallizing the residue from chloroform, brilliant fine white needles were obtained. They are readily soluble in chloroform and benzene, insoluble in petroleum ether, ether, alcohol, and water. The yield was about 0.05 per cent. Detailed investigation of a larger quantity is contemplated.

Extraction of Licorice Root with Alcohol.—Treatment of Extracts with Ether.—Ten kinds of root, after being picked over carefully to remove bad root and "stalk and stem," were shredded. The moisture content was about 10 per cent. The roots were dried *in vacuo* at ordinary temperature over sulphuric acid for several days until the moisture content dropped to 3.5–4.3 per cent. One hundred grams of each kind of root were then macerated with cold 95 per cent. alcohol. Three liquors were taken off, the first two being worked up together and the third separately, in order to be assured that the extraction was carried far enough.

The alcoholic liquors were evaporated *in vacuo* from a water bath. After weighing the dried extracts, they were treated as long as any resins dissolved, with ether which had been washed with water, dried over calcium chloride and redistilled.

The following tables show the distribution which occurred:

TABLE 8. DISTRIBUTION OF RESINS, BITTER PRINCIPLES, &C., IN LICORICE ROOTS.[11]

Kind of root.	Soluble in alcohol and ether (resins, &c.).	Soluble in alcohol, insoluble in ether. (Bitter principles, some sugars, &c.)	Total resins and bitter principles, &c.
	per cent.	*per cent.*	*per cent.*
Russian	4.12	8.16	12.28
Syrian	3.03	9.16	12.19
Anatolian	2.35	10.04	12.39
Turkish-Arabian	1.75	10.56	12.31
Italian	2.82	9.76	12.58
Spanish-Alicante	3.27	9.18	12.45
Spanish-Cordoba	2.96	8.97	11.93
Spanish-Zaragossa	2.07	8.78	10.85
Spanish-Seville	2.00	10.75	12.75
Spanish-Toledo	2.26	10.11	12.37

There is less difference between the various kinds of roots

[11] All results are on the roots as used, containing 4 per cent. moisture.

than might have been expected. In repeating the work, the above results were in the main confirmed. Considerable variations are caused by slight changes of root moisture, and also by using the root as received, without picking out the "stalk and stem." Since the roots usually contain at least 10 per cent. of "stalk and stem," derived from that part of the plant growing above the ground, it is of importance to separate this portion, in order to obtain comparative results.

The bitter principles were then treated with water, and in the soluble portion the sugars [12] were estimated. *No glycyrrhizin could be found in the 95 per cent. alcoholic extract.*

TABLE 9. TREATMENT OF BITTER PRINCIPLES &C, WITH WATER.

Kind of root.	Total bitter principles, &c.	Insoluble in water.	Soluble in water (non-sugars).	Soluble in water (sugars).
	per cent.	*per cent.*	*per cent.*	*per cent.*
Russian	8.16	2.29	3.05	2.82
Syrian	9.16	3.08	3.07	3.01
Anatolian	10.04	3.52	3.62	2.90
Turkish-Arabian	10.56	4.18	3.92	2.46
Italian	9.76	3.78	3.38	2.60
Spanish-Alicante	9.18	2.58	3.31	3.29
Spanish-Cordoba	8.97	3.20	3.18	2.59
Spanish-Zaragossa	8.78	2.93	3.05	2.80
Spanish-Seville	10.75	3.47	3.31	3.97
Spanish-Toledo	10.11	2.93	3.38	3.80

Extraction of Licorice Root with 50 Per Cent. Alcohol.—After the resins and bitter principles, together with some non-reducing sugars, had been extracted from the roots, they were macerated with 50 per cent. alcohol (by volume), which solvent was found to remove the glycyrrhizin quantitatively and very conveniently.

Four liquors were taken off, the fourth being worked up separately. In the fourth liquor the glycyrrhizin varied from 0.11 per cent. for Toledo to 0.57 per cent. for Anatolian, so that the extraction may be regarded as complete.

The 50 per cent. alcoholic extracts were evaporated *in vacuo* and weighed. They were almost completely soluble in water. Their amounts and composition are appended.

[12] The sugars consisted almost entirely of "non-reducing sugars."

TABLE 10. DISTRIBUTION OF GLYCYRRHIZIN, &C., IN LICORICE ROOTS.

Kind of root.	Total 50 per cent. alcohol extract.	Glycyrrhizin.[13]	Sugars.[14]	Substances not glycyrrhizin, but mostly precipitated by lead acetate.
	per cent.	*per cent.*	*per cent.*	*per cent.*
Russian	23.35	9.88	3.95	9.52
Syrian	20.00	7.44	3.40	9.16
Anatolian	30.95	13.24	4.53	13.18
Turkish-Arabian	23.45	8.87	4.46	10.12
Italian	23.98	9.18	2.72	12.08
Spanish-Alicante	27.24	10.06	5.13	12.05
Spanish-Cordoba	21.21	8.37	3.10	9.74
Spanish-Zaragossa	25.38	7.41	1.88	16.09
Spanish-Seville	21.96	7.16	4.50	10.30
Spanish-Toledo	20.48	5.89	1.56	13.03

The results described above may be conveniently brought together in one table.

TABLE 11. SUBSTANCES SOLUBLE IN ETHER, 95 PER CENT. ALCOHOL AND 50 PER CENT. ALCOHOL.

Kind of root.	Resins.	Bitter principles, &c., sol. in water.	Bitter principles, &c., insol. in water.	Glycyrrhizin.	Sugars.	Other substances sol. in 50 per cent. alcohol.	Total extraction with 95 per cent. and 50 per cent. alcohol.
	per cent.	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*	*per cent.*
Russian	4.12	3.05	2.29	9.88	6.75	9.52	35.61
Syrian	3.03	3.07	3.08	7.44	6.41	9.16	32.19
Anatolian	2.35	3.62	3.52	13.24	7.43	13.18	43.34
Turk-Arabian[1]	1.75	3.92	4.18	8.87	6.92	10.12	35.76
Italian	2.82	3.38	3.78	9.18	5.32	12.08	36.56
Spanish-Alicante	3.27	3.31	2.58	10.06	8.42	12.05	39.69
Spanish-Cordoba	2.96	3.18	3.20	8.37	5.69	9.74	33.14
Spanish-Zaragossa	2.07	3.05	2.93	7.41	4.66	16.09	36.21
Spanish-Seville	2.00	3.31	3.47	7.16	8.47	10.30	34.71
Spanish-Toledo	2.26	3.38	2.93	5.89	5.36	13.03	32.85

[1] The Turkish-Arabian root was not of a very good quality.

The Anatolian contains the highest percentage of glycyrrhizin, but also larger amounts of the other constituents. The bitter principles soluble in water are very uniform in the whole ten roots. Russian root contains the most resins.

[13] This glycyrrhizin was of a light brown color, and of a purer and stronger sweet flavor than that usually obtained from licorice mass by direct precipitation with sulphuric acid. It is free from associated resinous and bitter substances, and therefore the most convenient starting-out material for Tschirch's preparation of pure glycyrrhizin.

[14] The sugars were all "reducing sugars." (cf. 95 per cent. alcoholic extract, which contained "non-reducing" but no "reducing sugars.")

The resins are confined entirely to the bark,[15] as the following results show:

TABLE 12. DISTRIBUTION OF RESINS IN BARK AND DECORTICATED ROOT.

Kind of root.	Soluble in alcohol and ether (resins).
	per cent.
Anatolian (decorticated)	0.1
Anatolian (bark)	10.5
Syrian (decorticated)	0.7
Syrian (bark)	14.1

In actual factory practice, most of the resins remain in the spent root. In one series of experiments, various roots were given a strong extraction under 35 pounds' steam pressure, and the exhausted root, when dried and extracted with ether, showed that from 68–88 per cent. of the total resins remained in the spent root, and from 12 per cent. to 32 per cent. passed into the extract. The reverse is the case with the bitter principles, almost all of which pass into the extract.

In another series of experiments, the root was boiled with water in an *open* extractor. Five liquors were drawn off, each acting on the root for half an hour. Only a trace of glycyrrhizin was found in the spent roots, which, however, retained most of the resins—in one case as much as 98 per cent. of the total resins of the original root. In this series also, only about 10 per cent. of the bitter principles remained in the spent roots.

An examination for tannins, of licorice root and of the extract, by Procter's hide-powder method, showed a small quantity to be present, but far too little to play any important part in the chemistry of the root or extract.

An important subject, especially from a commercial standpoint, is that dealing with the changes in the constituents of licorice root during curing and extraction, and during evaporation of the extracted juice. The most important substance concerned is glycyrrhizin, and my own experiments, which I shall briefly communicate,

[15] The percentage of resins found in the roots will consequently vary with the *size* of the sticks taken. The smaller the sticks, the larger will be the proportion of resins they contain.

confirm the opinion of Tschirch [16] and Eriksson [17] that a portion of the glycyrrhizin is decomposed in extraction.

Ten roots similar to those used for the estimation of resins, bitter principles, glycyrrhizin, etc., were extracted in open copper extractors with boiling water, just enough steam being admitted to keep the water boiling. Five waters of half an hour each were taken off, and the liquors evaporated to a syrup *in vacuo,* and finished to about 25 per cent. moisture in a small, copper, steam-jacketed "finisher."

The following table contains the comparison of the glycyrrhizin contents of the roots and of the licorice pastes made from them. All results are calculated on roots containing 4 per cent. moisture.

TABLE 13.

Kind of root	Per cent glycyrrhizin in original root.	Glycyrrhizin in paste, calculated as per cent. of root.	Loss, as per cent. of root.	Per cent. decomposed of total glycyrrhizin.
Russian	9.88	7.10	2.78	28.1
Syrian	7.44	5.43	2.01	27.0
Anatolian	13.24	9.52	3.72	28.1
Turkish-Arabian	8.87	5.91	2.96	33.3
Italian	9.18	6.91	2.27	24.7
Spanish-Alicante[1]	10.06	4.90	5.16	51.3
Spanish-Cordoba	8.37	5.76	2.61	31.2
Spanish-Zaragossa	7.41	5.01	2.40	32.4
Spanish-Seville	7.16	4.88	2.28	31.8
Spanish-Toledo	5.89	4.28	1.61	27.3

[1] The result on Alicante should be rejected. A delay caused fermentation to commence in the liquor.

Estimations of glycyrrhizin in the liquors before evaporation showed that the loss of glycyrrhizin occurred partly during extraction and partly during evaporation. The proportions were rather uneven in the different roots, but in most cases the greater part of the loss fell on the extraction stage. The spent roots were practically free from glycyrrhizin.

It is not intended to regard the figures given in this paper as fixed standards for the ten roots examined. Considerable differences are found amongst the same kinds of root, due to many factors (such as age, curing, climatic conditions, size of root, admixture of "stalk and stem," etc.), some of which were not under control.

[16] Handbuch d. Pharmakog. II, p. 101.

[17] *Arch. d. Pharm.,* 1911, 249, p. 160.

SUMMARY.

1. A method of analysis for licorice mass is given, with comments thereon, and remarks on other methods proposed.
2. The constituents of licorice root, which were obtained by various solvents, have been quantitatively compared in ten different roots, and results given for resins, bitter principles, glycyrrhizin and sugars. The resins were shown to be confined to the bark of the root, and with mild extraction with hot water, they remain mostly in the exhausted root.
3. It was found that nearly one-third of the most important constituent of the root—the glycyrrhizin—is not accounted for when the root is extracted with hot water, and is presumably decomposed.

It is reserved for a future communication to describe the physical and chemical properties of the substances obtained in this investigation. It is also intended to transfer the knowledge gained of the constituents of the root, to improving the method of analysis of the extract, so as to include some of the undesirable constituents thereof.

For able assistance in the experimental work I am indebted to Messrs. Bertrand Schneeberg and Joel Harris. My thanks are especially due to the MacAndrews & Forbes Company of Camden, New Jersey, for liberal encouragement in work which has as one of its ultimate aims, the establishment, if it be possible, of chemical standards of quality and purity for licorice root and extract.

LABORATORY OF THE MACANDREWS & FORBES COMPANY,
Camden, New Jersey.
October, 1912.

CULTIVATION OF MEDICINAL PLANTS.

BY JOHN A. BORNEMAN, P.D., Lecturer in Pharmacy Hahnemann Medical College, Phila., Pa.

The cultivation of medicinal plants has been advocated from time to time for the past fifteen years, but it is only in recent years that the subject has been given the attention it deserves. Many of our most valuable medicinal plants, once abundant from

natural sources, are becoming exhausted, due no doubt to the larger demand for the drug, but more so because our forests are being destroyed and waste land devoted to agriculture. Since it has been proven that the cultivated plant yields as large and more often a larger amount of alkaloids or glucosides than the same species of the wild plant, there should be no reason why the cultivation of medicinal plants should not make rapid strides in this country.

I will take up the different plants that I have had under cultivation at the H. K. Mulford Drug Farm at Glenolden, Pa., and endeavor to show how successful the cultivation of drugs has been, also some of the difficulties that will be met with. The illustrations and assays will show that the cultivation is practical and even profitable, and most certainly becoming necessary in this country.

Digitalis purpurea L.

Digitalis purpurea is one of the easiest plants to cultivate, thoroughly acclimated in this country, and free from destruction by insects; it is the ideal plant for the amateur drug grower to begin with. The plants were grown from seeds purchased from Henry A. Dreer of Philadelphia, and the strain selected was digitalis gloxineæflora mixed; this species is the one that furnishes most of the fox glove found in our gardens and is very hardy. The plant can be raised from seed in a cold frame, hotbed or hothouse. If the seed is to be grown in a cold frame it should be sown in the fall; the soil should be well prepared, being a mixture of well rotted sod, manure and sand; it should be very fine and the soil sterilized. Seed should be sown in drills about one quarter of an inch deep and five inches between the rows; the soil should then be well firmed and covered with leaves. The plant can stand any ordinary amount of cold, but during very cold weather when the temperature goes down to zero it is advisable to cover the frames with matting or old carpet.

If it is desirable to start the plants in hothouses, the time to do so would be about the first week in March. The plants will come through the ground in about nine days and at the end of three weeks will be ready to transplant into pots or out in the plats. The soil in the plats should be of the same nature as that in the forcing houses and the plants should be set out when about two

inches high and have two or more leaves. The seedlings should be set in rows about five inches in the rows and about six inches

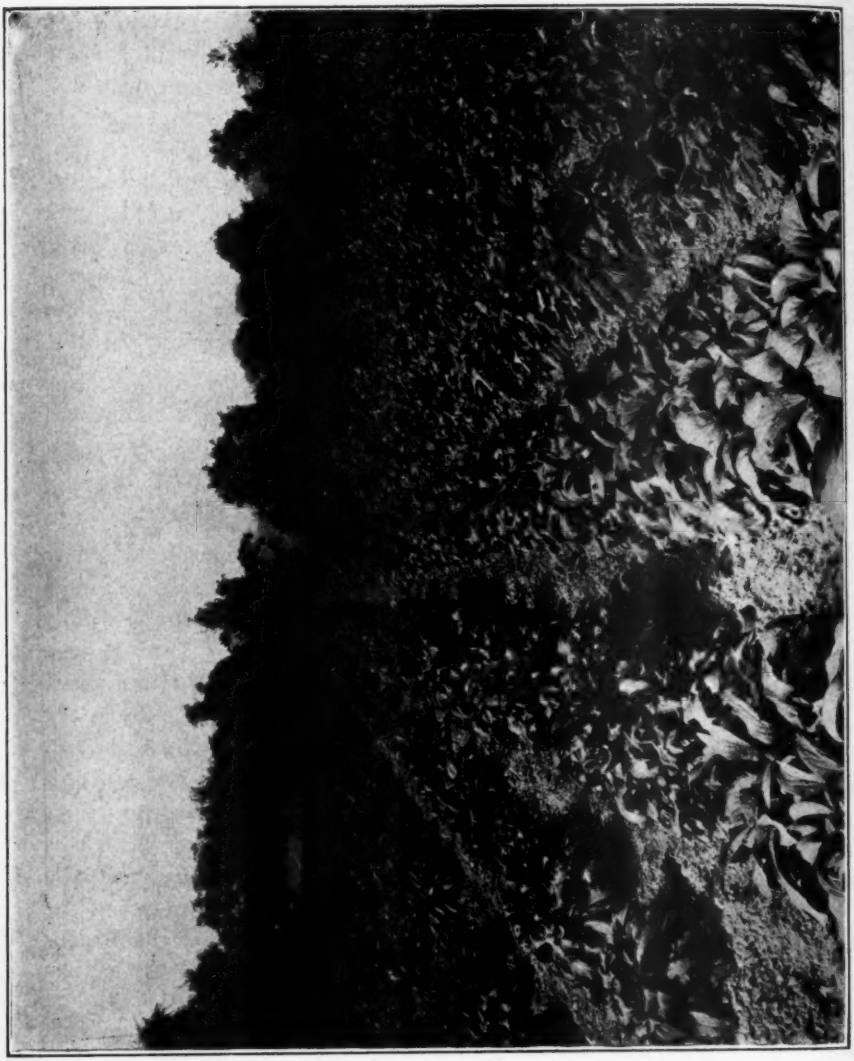


FIG. 1.

Digitalis purpurea; first year's growth, at The H. K. Mulford Co. Drug Farm, Glenolden, Pa., John A. Borneman, P. D., in charge.

between the rows. The plants should be left in the plats until they are about six inches high and have developed a good strong root, when they are ready to put out in the permanent bed; a day for

transplanting should be selected when there is not too much sun, and if possible, after a light rain; in that way the plant will have no set back and keep right on growing.

The soil for the seedling should be well prepared, having been limed and well mulched, and plowed the previous fall and again plowed and well harrowed just before setting out the plants. The soil should be fine, and if the weather is very dry the plants should be puddled or at least the roots kept in water until the plant is ready to put in the ground. The plants should be set out twenty-four inches in the rows and three feet between the rows. The plants must have good attention; the soil should be kept loose around the plants and the whole fields given a thorough cultivation at least once a week for the first month.

The plants seem to do better during a moist season, but make a good growth even during very dry weather. Each plant will average about two pounds by the first week in September and quite a few of them will flower the first year. It is very interesting to note that the first year's plant of digitalis shows a higher percentage of glucosides than that required by the pharmacopœia, and therefore should be admitted to the U. S. P. It would then pay to cultivate the drug as the yield of the first year is about three times that of the second year.

HARVESTING OF DIGITALIS.

The plant can be collected any time after flowering or even as late as September or October. The plants should be dried quickly by artificial heat; the ovens should be well ventilated and the heat gradually raised to 100° C. Drying will be complete in about twenty-four hours; the dry plants should be kept in air-tight containers with some freshly slaked lime.

ASSAY OF FIRST YEAR'S DIGITALIS LEAVES.

Digitoxin 0.304 per cent. Physiological report: Minimal lethal dose 0.6 c.c., corresponding to 166.669 of normal.

ATROPA BELLADONNA L.

The seed of belladonna can be sown in exactly the same way as the digitalis, but care must be taken not to bury the seed too deep, about a quarter of an inch is plenty; firm the soil lightly and cover with leaves. The plants should be transplanted into plats

Digitalis purpurea; first year's growth, at The H. K. Mulford Co. Drug Farm, Glenolden, Pa., John A. Borneman, P. D., in charge.

and set out in the field when about five inches high. The ground must be prepared in exactly the same way as for digitalis, and a

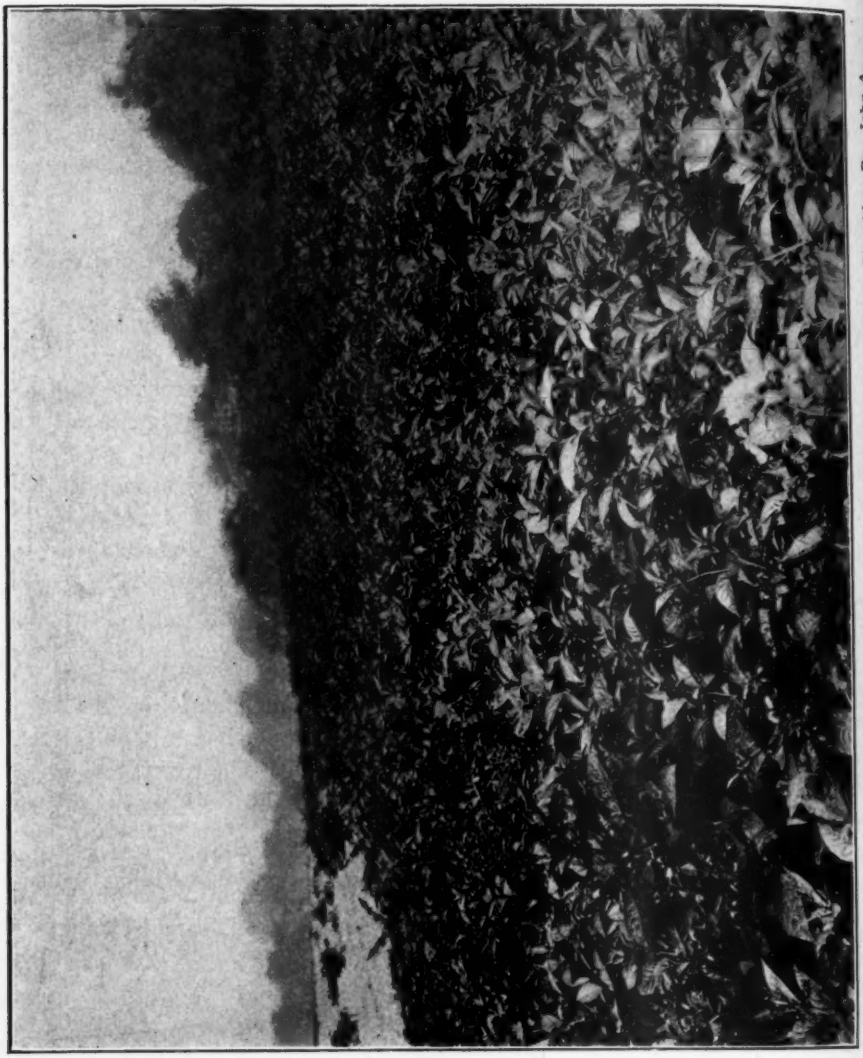


FIG. 2.

Atropa Belladonna; first year's plant, grown at The H. K. Mulford Co. Drug Farm, Glenolden, Pa., John A. Borneman, Ph.D., in charge.

day after a heavy rain should be selected to set out the plants. The roots should be cut back a little as well as the top of the plant.

The plant must have thorough cultivation at least once a week during dry weather. Care must be taken not to place the plants too close together, three feet in the rows and four feet between rows will be about right.

Care must also be taken to keep the young plants free from insects, and they should therefore be sprayed often; while the plant is still young it should be sprayed with lemon oil and whale oil soap, and as the plant becomes stronger a weak solution of lead arsenate may be used.

HARVESTING OF BELLADONNA.

The plant can be harvested any time in fall, but care should be taken to gather the plant at the first sign of the leaves becoming yellow. There is a rapid deterioration of the alkaloid as soon as the plant begins to turn, therefore it is advisable to look after the plant the latter part of August. The drying should be rapid an artificial means employed. The root of the first year should be buried during the winter and then divided and planted the next spring. The roots can be set out as early as the middle of March, and this will insure getting two cuttings from the belladonna the second year. The yield of fresh belladonna the first year is about twelve tons per acre.

Assay from plants of the first year.—Mydriatic alkaloid from roots, 0.53 per cent.; from leaves, 0.58 per cent.

HYOSCYAMUS NIGER L.

Hyoscyamus niger I have found to be the most difficult of all the Solonacea family to cultivate, owing to its destruction by insects. The seed is started the same as digitalis but only in hotbeds or forcing houses. The seedlings must be protected from insects while still in the forcing house, and must be fumigated often with tobacco or hydrocyanic acid fumes. After the plant is set out in the plats it must be sprayed every day with kerosene emulsion. After the plants have been set out in the permanent beds it will be necessary to spray the plants with Paris green almost every day or the potato bugs will devour the plants in one day. The plants stand the winter very well, but are very often destroyed the second year by wire worms getting to the roots and the potato bugs seem to like the plant the second year even more

Atropa Belladonna; first year's plant, grown at The H. K. Mulford Co. Drug Farm, Glenolden, Pa., John A. Borneman, P. D., in charge.

than they do the first year. If care is taken with the plants one is repaid with very beautiful specimens, but very much disappointed

FIG 3.

Hyoscyamus niger; first year's growth, at The H. K. Mulford Co. Drug Farm, Glenolden, Pa., John A. Borneman, P. D., in charge.

with the resulting assay, which very rarely comes above 0.06 per cent. I do not think that it will pay to raise this plant unless

it is possible to bring the assay up to standard and getting a good price for the drug.

Assay of the second year leaves.—Mydriatic alkaloids 0.06 per cent.

Cannabis sativa L.

Cannabis sativa and *Cannabis indica* can be very readily cultivated. The seed can be sown in the cold frames or hotbeds, and when about four inches high can be set out at once in the field. The ground should be well mulched and not contain too much clay. The plants should be set out about three feet in the rows and four feet between the rows. The plants make a very rapid growth and often reach a height of about twelve feet in three months. The male plants should be removed, and the plant harvested about the time the seed develops.

Hydrastis canadensis L.

Propagation is best carried on by means of dividing the roots; the plant can be transplanted during spring or late in fall. I made my planting from the fresh roots during the month of May; planting the rhizomes in the shady woodland, which had previously been put in shape by removing all shrubbery and wild vegetation. The soil was very rich in decayed leaf mould. The rhizomes were cut in several pieces and then set in the ground in rows six inches each way, and the whole field covered with leaf mould. All the plants made a rapid growth and can be taken up during the fall of the second year and again be divided, so that in a few years I should have several acres of hydrastis plants. I think the best method of raising hydrastis would be by producing artificial shade; while that would be the most expensive way to begin, I think it would pay in the yield of hydrastis. I think that the plant which is raised in the woodland makes a very much slower growth and does not nearly assay so well as that raised under artificial shade.

Hydrastis cultivation is very simple and all the plant requires is that it be kept free from weeds and grass; it does not require any cultivation to speak of, and can stand the winter very well. I think it would pay anyone to cultivate the drug as the price is advancing all the time.

PROGRESS IN PHARMACY.

A Quarterly Review of Some of the More Interesting Literature Relating to Pharmacy and Materia Medica.

By M. I. Wilbert, Washington, D. C.

Prospective legislation is still attracting the attention of pharmacists in practically all sections of the country, and at the annual conventions of associations related to the various sections of the drug business considerable time was devoted to the discussion of legislative matters.

In many of the states the legislatures will be in session during the coming winter and efforts will undoubtedly be made to bring about greater uniformity in the requirements embodied in the food and drug laws and probably in other legislation relating to or affecting the practice of pharmacy. This is indicated by the evidently growing appreciation of the frequently made statement that greater uniformity between National and State food and drug laws would be favorable to the more economical conduct of interstate business and several at least of the National organizations have placed themselves on record as being in favor of greater uniformity in State and National legislation.

Anti-narcotic legislation was also discussed quite extensively and many of the more influential members of the drug trade appear to appreciate the need for some form of regulation to regulate the interstate traffic in narcotic and habit forming drugs. That State legislation of this kind is becoming more satisfactory is evidenced by the phraseology of the laws recently enacted in Kentucky and in Maryland. Both of these laws are designed to include a greater number of narcotic substances than have been included heretofore.

Another legislative subject that is attracting more than passing attention is the use and sale of methyl or wood alcohol. Two states, Rhode Island and New Jersey, have recently enacted laws forbidding the use of this substance in food or drink and otherwise safeguarding its use.

The passage by Congress of the Sherley amendment to the Pure Food and Drug Act is generally considered to be a satisfactory solution of the evident need of the National law and the amendment should tend to protect the honest manufacturer and dealer as well as the public.

INTERNATIONAL PHARMACEUTICAL FEDERATION.—The organization meeting of the federation was held at The Hague in September and the reported discussions promise that this organization is destined to be a factor in the future progress of pharmacy. The *Pharmaceutical Journal* (1912, v. 35, p. 481) points out that the Bulletin of the International Pharmaceutical Federation, which has now been issued, is a well printed book of 290 pages, containing the rules of the Federation and particulars concerning pharmacy in a number of countries.

INTERNATIONAL CONGRESS OF PHARMACY.—The eleventh International Congress of Pharmacy is to be held at Scheveningen, a charming seaside resort, within easy walking distance of The Hague, so that the members of the Congress who prefer to do so may "put up" at the latter city without any inconvenience. His Royal Highness Prince Henry has consented to bestow his patronage on the Congress.—*Pharm. J.*, 1912, v. 35, p. 313.

The preliminary program, a pamphlet of 28 pages, indicates that the Congress has been planned on rather broad lines and is destined to attract members from all portions of the world.

PHARMACEUTICAL EDUCATION.—An editorial (*Chem. and Drug.*, 1912, v. 81, p. 300), in discussing pharmaceutical education, points out that degrees in pharmacy are granted by two British Universities—viz., Manchester and Glasgow—but so far few persons have availed themselves of the opportunity of becoming graduates of these institutions.

COLLEGE OF PHARMACY, AN EARLY.—Schelenz, Hermann, calls attention to a book by Alfred Poussier on the institution at Rouen in the beginning of the sixteenth century of a college of pharmacy and an analytical laboratory. This college was evidently the outcome of the inability or unwillingness of apothecaries to teach their apprentices and the general recognition that systematic instruction would be of advantage to them.—*Pharm. Zentralh.*, 1912, v. 53, p. 1082.

U. S. PUBLIC HEALTH SERVICE.—The Treasury Department bureau known formerly as the Marine Hospital Service and recently as the Public Health and Marine-Hospital Service has within the last month become, by virtue of a new legal provision, the United States Public Health Service. Its activities have so expanded in recent years that the care of the Marine hospitals has become but a minor part of them. The Public Health Service is one of the most prolific publishers among the Government bureaus and its publica-

tions are in active demand. Its weekly magazine, "Public Health Reports," is in its 27th annual volume, and 89 articles from it have been separately printed in pamphlets known as "separates." Its bulletins from the Hygienic Laboratory number 84 and those from the Yellow Fever Institute 17. In the series called Public Health Bulletins there are 53 separate publications. The annual reports of the Service began in 1872.—*Monthly Catalogue United States Public Documents No.* 212, August, 1912, page 77.

THE DRUGS WE NEED.—Osborne, Oliver T., in discussing the drugs that we need, points out that the physician could succeed with a remarkably few of the present official drugs. He states that a thorough knowledge of the pharmacologic activities of some drugs and of the pharmacologic uselessness of other drugs is now necessary in the preparation of the medical student. Having such knowledge, he will not make the mistakes long made in the use of drugs. Osborne believes that instruction in and examination on useless drugs only will be a cure for the mistake of using nostrums, proprietaries, or even absurd and useless pharmacopœial preparations.—*J. Am. M. Assoc.*, 1912, v. 59, pp. 1160–1163.

DRUG THERAPY.—Calvin, W. D., thinks that 95 per cent. of the practitioner's drug therapy is done with fewer than ten drugs, and while he does not believe less in drug therapy than he did when he left college, he has much less confidence in most of the drugs of the Pharmacopœia than he had at that time.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1164.

MEDICINES, USE OF.—Wilbert, M. I., in a report of the work of the Committee on Useful Remedies, points out that the present misuse of medicines has been designated as consisting of a series of vicious circles: Patent medicines are used by the laity because they are advertised by manufacturers, and they are advertised by manufacturers because they are used by the laity. The closely related proprietary medicines are prescribed by physicians because they are advertised in medical journals, and they are advertised in medical journals because this leads to their being prescribed by physicians. Official remedies are official because they are endorsed by text-books, and are endorsed by text-books because they are official. *J. Am. M. Assoc.*, 1912, v. 59, p. 1163.

COUNCIL ON PHARMACY AND CHEMISTRY.—An editorial (*J. Am. M. Assoc.*, 1912, v. 59, p. 291) points out that German physicians have finally come to recognize the evil connected with the proprietary medicine business and the extent to which this is a detriment to the

progress of medicine and have organized a German council on pharmacy and chemistry to be known as Die Arzneimittelkommission des Kongresses für innere Medizin. The commission has collected from twenty-one of the most widely circulated German and Austrian medical journals about 1,000 advertisements of remedies, and after careful investigation has arranged them in three lists. (See AM. J. PHARM., September, 1912, p. 415).

NEW REMEDIES.—An unsigned article (*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 512) points out that the pharmaceutical laboratories of the Universities of Bonn, Giessen, Göttingen, and Munich have contributed a number of communications on the examination of medicines and articles recommended for use as medicines. These communications have been printed in the pharmaceutical and medical journals and have no doubt contributed materially toward arousing an appreciation of the need for reform in medical practices.

PROPRIETARY MEDICINES.—In Great Britain the House of Commons Committee, appointed to inquire into the sale of patent and proprietary medicines and medical preparations and appliances, and advertisements relating thereto, is getting together a mass of evidence that will no doubt have a marked influence on the future development of the manufacture and sale of proprietary remedies in this country as well as in Great Britain. W. E. Dixon, in discussing some of the abuses of the proprietary trade at a recent hearing before this committee, stated that at the present time the medical profession and retail chemists are in many cases greatly fogged by the large number of proprietary names for one and the same substance. Acetyl salicylic acid, for instance, is being sold under the names: aspirin, salacetin, saletin, xaxa, etc. The aryl arsenates have several names, such as atoxyl and soamin. Dixon thinks that one name only should be allowed to each substance.—*Chem. and Drug.*, 1912, v. 81, p. 690.

TRADEMARKS.—Wickboldt, in discussing German trademark laws and the proposition of Rathenau to restrict trademarked names to one and declare this public property as soon as it becomes widely used, suggests that the government in granting a trademark also undertake to regulate the price of trademarked articles so as to prevent inordinate profits.—*Therap. Monatsh.*, 1912, v. 26, pp. 724–726.

PATENT MEDICINE.—An editorial (*Nat. Druggist*, 1912, v. 42, pp. 414–415) calls attention to some census figures on patent medicine production to demonstrate that the long continued warfare that has been waged against the patent medicine business has served to

increase rather than diminish the volume of business done. The editorial states that the number of establishments engaged in the manufacture of patent and proprietary medicines in 1899 was 2,154, in 1904 2,777, and in 1909 3,642. The value of the products at the factories in 1899 was $88,791,000, in 1904, $117,436,000, and in 1909, $141,942,000. The figures as to value of products do not mean the total value at retail, but at the factory. Of course, some part of this great increase in value of products is occasioned by the higher cost of raw materials and of manufacture.

MEDICINAL PLANT CULTIVATION.—An editorial note (*Pharm. J.*, 1912, v. 35, p. 313) states that medicinal plant cultivation is about to be undertaken on an extensive scale in Hungary, where labor of the kind required is cheap and other conditions appear to be favorable to the project. One of the prime movers in the matter is the President of the Hungarian Pharmaceutical Society, and many manufacturing chemists and pharmacists have identified themselves with the scheme.

An unsigned article (*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 505) calls attention to a report by Mitlacher on some recent experiences in the cultivation of medicinal plants.

An editorial note (*Pharm. J.*, 1912, v. 35, p. 363) discusses the possibility of improving drug plants by the employment of standard methods of breeding, such as the selection of seed and young plants, the isolation and testing of favorable varieties, the study of soil and climatic conditions, trials in hybridization, grafting, or other methods which might prove applicable.

STERILIZATION.—Holz, Max, reviews the requirements made by the several Pharmacopœias in regard to sterilization, and concludes that in connection with the preparation and sterilization of medicines there is still much to be done for hygiene.—*Centr. Bakt. Parasitenk.*, 1912, v. 64, pp. 81–86.

ALCOHOL, ANTISEPTIC PROPERTIES OF.—An unsigned article (*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 631) points out that the fact that 70 per cent. alcohol is more active as an antiseptic than either higher or lower concentrations is thought to be due to the peculiar action of this strength of alcohol on dried albumen. It has been found that only the moderate concentration changes albumen in the sense of a coagulation so that its faculty of swelling and dissolving in water is lost. Both the weaker and stronger concentrations are less active in this respect.

GERMAN PHARMACOPŒIA.—The fifth edition of the German

Pharmacopœia is still being actively discussed in the Pharmaceutical Journals of Germany and the Continent of Europe generally. While the tenor of this discussion is generally favorable it is nevertheless critical and designed to call attention to the several errors of omission and of commission that are embodied in the Pharmacopœia.

TINCTURES.—Richter, R., in discussing the tinctures of the Ph. Germ. V states that the practice of making tinctures by maceration has been retained in this pharmacopœia much to the surprise of German pharmacists who have repeatedly pointed out that percolation gives results that are more generally satisfactory than does maceration. He also points out the desirability of comminuting the several drugs at the time they are to be used rather than buying commercial powdered drugs. This is further emphasized by the impracticability of controlling the nature of the powdered drug. —*Pharm. Zentralh.*, 1912, v. 53, pp. 1943–1946.

WEIGHTS AND MEASURES.—An editorial (*Pharm. J.*, 1912, v. 35, p. 416) expresses the belief that metric weights and measures will probably never become established as an exclusive system in this country; they may not be used, in the immediate future, if ever, to any greater extent than obtains at the present. It is only in scientific literature where we find the system firmly placed on a practical basis. Clumsy and inconvenient as our British tables of weights and measures may sometimes be, there is absolutely no substantial sign of their giving way to the attacks made on them by advocates of the metric system.

ACETYLSALICYLIC ACID.—Anderson, H. B. (*Canadian Pract. and Rev.*, September), cites two cases of angioneurotic eruption due to acetylsalicylic acid. Both patients suffered with slight digestive disturbances and constipation, but were otherwise quite healthy. The administration of acetylsalicylic acid in 5 grain doses was promptly followed by a marked generalized urticarial eruption. The itching was intense, the lips swollen and in one case the face was so swollen as to close the eyes.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1470.

ALCOHOL-GLYCERIN.—Dörken, Fritz, suggests the use of equal parts of alcohol and glycerin as a wet dressing in place of lead water and laudanum, solution of aluminum acetate and other similar preparations. He thinks that the alcohol and glycerin preparation is more cleanly and in many ways more satisfactory than any of the other commonly used wet dressings. The preparation is strongly antiphlogistic and comparatively non-irritating.—*Therap. Monatsh.*, 1912, v. 26, pp. 711–721.

ALENDRIN.—Alendrin, the carbaminic acid ester of *aa*-dichlorisopropylalcohol, occurs as white odorless crystals that melt at 82°, is slightly soluble in alcohol and readily soluble in other organic solvents and in fatty oils.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 605.

ALLANTOIN.—An oxidation product of uric acid; occurs as colorless crystals that melt at 226°. Allantoin is readily soluble in hot water or in alcohol.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 605.

ANTIKAMNIA.—An editorial (*J. Am. M. Assoc.*, 1912, v. 59, p. 1550) calls renewed attention to the claim that antikamnia sold in Great Britain has a different formula from the antikamnia sold in the United States, and reports that a package of antikamnia recently purchased in Great Britain, on examination, was found to contain acetanilid.

APIOL.—Lutz and Oudin (*Annales des Falsifications*) think that, where possible, green apiols should be rejected in preference to yellow apiols prepared by saponification or apiolines decolorized by animal charcoal.—*Chem. and Drug.*, 1912, v. 81, p. 686.

ARTIFICIAL MILK.—An editorial note (*Pharm. J.*, 1912, v. 35, p. 482) points out that milk from soya beans is a product which may be used on an extensive scale in the near future. Nearly all the daily papers are devoting paragraphs to descriptions of the production of an "artificial milk made by machinery." The new milk is described as a "synthetic product composed from cereals and water. The fat of the soya bean is a considerable ingredient, and other fats, as well as beet sugar, enter into it." It can be made as thick as desired and the ordinary "family milk" brand of this product is said to be 15 per cent. more nutritious than the best cow's milk, and it could be sold profitably at threepence per quart.

ASAFETIDA.—Koenig, Paul, discusses the varied uses for asafetida in Egypt and points out that it is one of the popular remedies for increasing the weight of females and is generally believed to be valuable as an insecticide.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 497.

Bufagin is the name applied by Abel and Macht to a secretion of the parotid gland of the toad, *Bufo agua;* this substance has a digitalis-like action. Clinical experiments have as yet not been reported.—*Südd. Apoth.-Ztg.*, 1911, v. 52, p. 605.

CALCIUM GLYCEROPHOSPHATE, POOR QUALITY OF.—Puckner, W. A., in reporting on five samples of this article, points out that none of the specimens examined complied with the generally accepted requirements for solubility in water, and that those which were most nearly soluble were such as contained considerable quan-

tities of an organic acid.—*J. Am. M. Assoc.*, 1912, v. 59, pp. 134–135.

CALCIUM PHENOLSULPHONATE, NATURE OF COMMERCIAL.—Puckner, W. A., reports that, although calcium phenolsulphonate is a distinct chemical substance and is sold by several manufacturers of chemicals, examination showed that the several brands differed considerably in composition and were unsatisfactory as to purity. —*J. Am. M. Assoc.*, 1912, v. 59, p. 1157.

CAMPHOR.—An editorial note (*Pharm. J.*, 1912, v. 35, p. 363) points out that the distillation of camphor from leaves is to be commenced on a practical scale in Formosa. Experiments have been carried on for five years, and it has been found that the best results are obtained from the use of the leaves only, branches not being cut. The export of camphor from Formosa last year showed a decrease of nearly nine hundred thousand pounds. The largest purchaser was Germany, which took four times as much as the United Kingdom.

CAMPHOR, POISONING BY.—An abstract (from *Zentralbl. f. Gynäcologie*) calls attention to a fatal case of poisoning from the use of camphorated oil in the peritoneal cavity.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 538.

CANNABIS INDICA.—Xrayser II points out that cannabis indica has fallen greatly into disuse in Great Britain, and it now matters little whether the drug is produced in Asia, Africa or America. Quite possibly this lack of interest has been brought about by our failure to ensure that our preparations are always active.—*Chem., and Drug.*, 1912, v. 81, p. 547.

CHAVOSOL is the methyl ether of chavicol, which may also be described as para-allyl-phenol, $C_6H_4C_3OH$. It is a fragrant aromatic liquid, having a powerful bactericidal action, and is being introduced as a disinfectant for dental work.—*Pharm. J.*, 1912, v. 35, p. 298.

CINCHONA.—Horper, D., in a discussion on the introduction of cinchona into Java, states that Hasskarl in 1852 introduced 500 Calisaya seedlings from South America.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 454.

COCAINE.—An editorial note (*Pharm. J.*, 1912, v. 35, p. 363) points out that the use of cocaine in India is becoming a very serious evil, the natives having acquired the cocaine habit. In order to strengthen the hands of the Excise department, the Bombay Government has introduced an amendment of the existing law designed

to check the illicit importation of cocaine, and giving officers the power to secure surety bonds from the accused charged with an offence; the amendment also enables a magistrate to impose a term up to two years' imprisonment, and a fine of Rs. 4,000.

COFFEE.—An abstract presents a compilation of the per capita consumption of coffee in the several countries. This varies from 15.12 pounds in Holland, 1.33 in the United States, 5.80 in Germany, to 0.65 pounds in England. The extremely low consumption in England is thought to be due to the exceptionally large consumption of tea.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 539.

DIGITALIS.—Weiss, E. (*Oesterr. Sanitätswesen*, Beilage zu No. 22, v. 30, 1912), presents a comprehensive report on a comparative study of preparations of digitalis. He concludes that the most active and most reliable form of digitalis preparation is a freshly made infusion. The precaution should be observed to use a reliable drug, to have the infusion freshly prepared and not to use the infusion after it is 12 hours old.—*Schweiz. Wchnschr. f. Chem. u. Pharm.*, 1912, v. 50, pp. 486–488.

DIORADIN.—A report of the Council on Pharmacy and Chemistry of the American Medical Association, in reviewing the claims made in regard to the composition of this product, points out that they have been largely vague statements and contradictions which arouse a feeling of uncertainty and lack of confidence. Until this uncertainty is cleared away, dioradin is not eligible for inclusion in New and Non-Official Remedies.—*J. Am. M. Assoc.*, 1912, v. 59, pp. 1556–1558.

HEXAL.—This is the name applied to hexalmethylenetetramine sulpho-salicylate which occurs as white crystals that are readily soluble in water but more difficultly soluble in alcohol or ether; on heating to about 45° a distinct odor of formaldehyde is produced. Hexal is recommended as a urinary antiseptic to be given in doses of 1 gram 3 to 6 times a day.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 605.

KERATIN, POOR QUALITY OF COMMERCIAL.—Puckner, W. A., reports that a sample of keratin examined by him was found to be almost completely (98.73 per cent.) soluble in hydrochloric acid-pepsin solution, and apparently no satisfactory product is being marketed at the present time.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1157.

MAGNESIUM PEROXIDE, DEGREE OF PURITY OF.—Puckner, W. A., reports that while MgO_2 is advanced as a chemical formula for magnesium peroxide, examination in the laboratory showed that

the several commercial brands contain only 12.17 to 25.18 per cent. of real magnesium peroxide.—*J. Am. M. Assoc.*, 1912, v. 59, pp. 1157–1158.

MENTHA PIPERITA.—Mossler, G. (*Pharm. Post*), reports a number of experiments in the cultivation of peppermint. He found that the use of ordinary stable manure increased the yield of oil 10 per cent. Artificial fertilizers like potassium nitrate or potash had little or no influence.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 550.

MENTHOL.—An editorial (*Chem. and Drug.*, 1912, v. 81, p. 614) points out that the rapidly increasing use of menthol in Europe and the United States is leaving but a narrow margin between consumption and production. In the United States, for instance, the imports of menthol have increased from 20,183 pounds in 1908 to 50,533 pounds in 1911. The reputed value of the amount imported has increased from $33,240 in 1908 to $122,977 in 1911.

MERJODIN.—Merjodin is the name applied to the diiodparaphenol-sulphonate of mercury. It has been recommended as a reliable anti-syphilitic in secondary and tertiary lesions.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 605.

PYRAMIDON.—An editorial (*J. Am. M. Assoc.*, 1912, v. 59, pp. 461–462) calls attention to the advertisements in newspapers of a new "headache cure," the advertising slogan of which is that it "contains no acetanilid or phenacetin." The name of the preparation is *midol*, and on examination it was found to depend essentially on pyramidon for its therapeutic effects. A second preparation of the patent medicine type in which pyramidon is the essential drug, is *nurito*. A quantitative examination indicates that the composition of nurito is essentially as follows: milk sugar, 34 per cent.; phenolphthalein, 6 per cent.; and pyramidon, 60 per cent.

QUININE, USE OF.—An unsigned note (*Chem. and Drug.*, 1912, v. 81, p. 498) points out that while quinine has long been a staple product of importation into the United States, no marked growth in its imports has occurred in the last quarter of a century. In 1882, for example, over 5 million lb. of cinchona bark was imported; in 1892, 3½ million lb.; in 1902, 3¾ million lb.; and in 1912 the imports will probably be about 3½ million lb. In 1882 the imports of quinine and the various salts of quinine amounted to 795,000 oz.; in 1884, 1½ million oz.; in 1892, 2⅝ million oz.; in 1902, 2⅝ million oz.; while the rate of importation in the nine months of the current fiscal year for which figures are at hand point to a total of about 3 million oz. in the twelve months ending with June.

QUININE TANNATE, QUALITY OF COMMERCIAL.—Puckner, W. A., reports that while quinine tannate is official in most foreign pharmacopœias, and is required to contain not less than 30 per cent. of anhydrous quinine alkaloid, examination of the commercial products available in this country showed them to be of only fairly good quality. One sample contained about 9 per cent. of uncombined alkaloid and, consequently, was bitter and unfit for use.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1158.

SANTONIN.—An editorial note (*Pharm J.*, 1912, v. 35, p. 313) calls attention to the steady advance in the price of santonin, which, at the present quotation, is more than double the price of silver, and about twenty-five times the price at which the glucoside could at one time be bought. It is also curious to note that so far from the high price checking the consumption of santonin, the demand has actually increased with the advancing prices.

TANNAPHTHOL.—Tannaphthol is the name applied to a condensation product of tannin albuminate and benzonaphthol. It is being used as an astringent in diarrhœa in doses of 0.5 to 1 Gm. Also used as an antiseptic powder.—*Südd. Apoth.-Ztg.*, 1912, v. 52, p. 605.

TRAGACANTH.—Fromme, G. (Cæsar & Loretz, *Jahres-Ber.*, 1912, pp. 89–91), found the borax test referred to by Fuller (*Am. J. Pharm.*, 1912, v. 84, pp. 155–158) to be misleading. Samples of tragacanth that were known to contain Indian gum did not respond to the test, while samples of genuine tragacanth were found to yield a jelly that even when treated with solution of borax for the required time did not become sufficiently liquid to pour.

VERONAL.—A reply to a query states that like other hypnotics, veronal may lead to the formation of a habit, but there is as yet practically no literature on the subject.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1392.

In an inquest on the body of a woman, who died as the result of taking an overdose of veronal, the jury in returning a verdict of "Death from misadventure," added a rider to the effect that the indiscriminate sale of veronal should be checked.—*Pharm. J.*, 1912, v. 35, p. 328.

ZINC PERMANGANATE, NATURE OF.—Puckner, W. A., reports that zinc permanganate as found on the market was found to vary considerably. While the best specimens contained as high as 97 per cent. of the theoretical amount, others contained but about 73 per cent.—*J. Am. M. Assoc.*, 1912, v. 59, p. 1158.

NOTES ON ELIXIR FERRI, QUININÆ ET STRYCHNINÆ PHOSPHATUM U. S. P. AND AN IMPROVED FORMULA.

By W. L. Cliffe, Philadelphia.

The present U. S. P. formula for the elixir of iron, quinine and strychnine phosphates, appears to be unnecessarily complicated in technique and quite liable to yield unsatisfactory results in the hands of other than skilful pharmacists.

As the chemical necessity exists for the use of an intervening solvent it appears to the writer that the use of an alkaline phosphate that is stable in character like phosphate of soda would be more in accord with the title and formula and very much simpler in detail than the ammonium acetate in use at present.

The phosphate of quinine is also present to nearly the limit of solubility and in constructing the proposed formula it was deemed wise to take advantage of the well-known action of the organic acids, like lactic acid, which exert upon the solubility of the alkaloidal phosphates a similar influence to that upon the earthy phosphates.

The simplified formula and process based upon these premises is as follows:

Soluble ferric phosphate	17.500 Gm.
Sodium phosphate	17.500 Gm.
Quinine	8.750 Gm.
Strychnine	0.275 Gm.
Phosphoric acid, U. S. P.	2. c.c.
Lactic acid, U. S. P.	4. c.c.
Hot distilled water	150. c.c.
Alcohol	50. c.c.
Aromatic elixir q. s. to make	1000. c.c.

Dissolve the quinine and strychnine in the alcohol and add the phosphoric acid; stir until a magma is formed and then add the lactic acid, stirring until solution is effected; to this solution add 700 c.c. of aromatic elixir.

Dissolve the soluble ferric phosphate and the phosphate of soda in the hot distilled water; add this solution to that previously made and enough aromatic elixir to make 1000 c.c.

The result is a bright clear yellow green elixir that possesses every desirable feature from a physical and chemical point of view

and can be made in a few minutes without special manipulation. It contains the same dosage of all active ingredients as the present U. S. P. preparation.

BOOK REVIEW.

OUTLINE OF COURSES IN BOTANY, MICROSCOPY, AND PHARMACOGNOSY. Henry Kraemer. Philadelphia and London: J. B. Lippincott Company.

Although this pamphlet of 50 large 8vo pages is primarily designed to facilitate instruction in Botany and Pharmacognosy in Colleges and Schools of Pharmacy it also presents exceptional possibilities for home study on matters relating to pharmacognosy. With the rapidly increasing need for better knowledge regarding the structural characteristics of the more important drugs and with the evident probability that structural characteristics of drugs and the appearance of powdered drugs under the microscope will be described at some length in the coming edition of the Pharmacopœia of the United States there is every indication that the pharmacist who wishes to maintain his position must be thoroughly conversant with the microscope and its possible uses. For the student who is desirous of reviewing the work that he has had in the college of pharmacy and for the pharmacist who is desirous of preparing himself for the requirements of the very near future this pamphlet offers opportunities not readily found elsewhere. For the practical development of a course of home study it would be desirable to have a set of authentic type drugs and a collection of permanent microscopic slides for control. Arrangements could no doubt be made for supplying the necessary materials and with such an equipment any pharmacist should be able to prepare himself for the very much higher requirements that he will be obliged to comply with on the publication of the U. S. P. IX. M. I. W.

THE DETERIORATION OF DRUGS.

The investigations of Hale [1] on digitalis, of Edmunds and Hale [2] on ergot, and Dohme [3] on calabar bean, coca and aconite, have revealed the facts that many drug preparations deteriorate, and that

[1] Referred to editorially in The Journal A. M. A., April 22, 1911, p. 1198.
[2] Referred to editorially in The Journal A. M. A., March 9, 1912, p. 705.
[3] Dohme, A. R. L.: Am. Druggist, 1909, lv, 37.

drugs are often several years old when they reach the patient. These facts have been emphasized, also, through a report of the Council on Pharmacy and Chemistry, dealing with the testing of epinephrin solutions in which the Council recommends that "manufacturers stamp the age of manufacture on the container, to guard against samples which are obviously overaged." Naturally some manufacturers have asserted that the reported deterioration is accidental, or have tried to put the blame on the pharmacist. Some have shifted their previous claims as to strength in such a way as to avoid responsibility. Some firms, however, instead of attempting to dodge responsibility, are doing what ought to be done, and indicate the date of manufacture on the label of those preparations which are prone to deterioration. This, for instance, has been done by Fairchild Bros. & Foster for their Lactic Bacillary Tablets (N. N. R. Supplement, 1912, p. 5); by Hynson, Westcott & Co. in the case of their Bulgara Tablets (N. N. R., 1912, p. 127) and by the H. K. Mulford Co. for their Cornutol (N. N. R. Supplement, 1912, p. 2) and Digitol (N. N. R. Supplement, 1912, p. 3). A serious attempt to overcome deterioration has been made in a recent report by Pittenger and Vanderkleed,[4] of the scientific staff of the H. K. Mulford Co., on methods for the preservation of fluidextract of ergot. They found that a fluidextract of ergot, put up in hermetically sealed vials, kept its strength for a year without the least change.

While most pharmaceutical houses appear indifferent to the demands of modern medicine, there are signs, nevertheless, that scientific pharmacy is making headway.—*Jour. A. M. Assoc.*, Sept. 21, 1912, p. 959.

SCAMMONY ROOT AND SCAMMONY RESIN.

From the results of the investigations by Power and Rogerson (*Trans. Chem. Soc.*, vol. 101, 1912, pp. 389–412) it will be seen that the resins obtained from scammony root and from the gum-resin known as scammony, although similar in their general characters, are not perfectly identical. On the other hand, a com-

[4] Pittenger, P. S., and Vanderkleed, C. E.: Jour. Amer. Pharm. Assn., 1912, i, 709.

parison of the resin from scammony root with that obtained from the root of *Ipomoea orizabensis* (*Ibid.*, p. 1) shows that these two products differ very considerably in their composition. Both of these resins are exceedingly complex in character, but consist to a large extent of the glucosides and methylpentosides of jalapinolic acid, $C_{15}H_{30}(OH)CO_2H$, and its methyl ester. Whilst, however, the methylpentose obtained by the hydrolysis of the resin from scammony root appears to be identical with rhamnose, that from the resin of *Ipomoea orizabensis* yields a crystalline tetra-acetyl derivative, which had not heretofore been described. The resin from the last-mentioned source contained, among other substances, small amounts of hentriacontane, $C_{31}H_{64}$, and cetyl alcohol, $C_{16}H_{34}O$, which were not present in the resin from scammony root, and, furthermore, very marked differences were observed in extracting both the crude resins and the products of their alkaline hydrolysis with various solvents. It is not to be expected, however, that products of this nature would be uniform in composition, and the differences which have now been observed to exist between them may not be constant, or such as appreciably to influence their therapeutic value.

In view of the complexity of the above-mentioned resins, it is evident that they cannot be represented by chemical formulæ, a fact which they had previously indicated in connection with the investigation of jalap resin (*J. Amer. Chem. Soc.*, 1910, **32**, 112). The names by which the resins now under consideration have heretofore been designated, such as "jalapin" or "scammonin," with the assumption that they were individual substances, should, therefore, also be discarded.

THE "WELLCOME" PHOTOGRAPHIC EXPOSURE RECORD AND DIARY, 1913.—Within its closely packed pages this book contains a surprising number of useful and practical paragraphs for the field, the dark room and the studio. Among the most novel features are the descriptions of new methods of toning prints green and blue, by the use of "Tabloid" toners which act selectively, leaving the high lights only faintly colored. There are also some interesting new notes on the technique of color photography, and on modern methods in development.

INDEX

TO VOLUME 84 OF THE AMERICAN JOURNAL OF PHARMACY.

AUTHORS.

Baker, W. F. How far variations in frogs can be obviated by the use of ouabain 247
Becker, M., H. M. Sechler and. Detection of gum ammoniacum and gum galbanum in asafetida 4
Beringer, George M. Cudbear as a pharmaceutical coloring..... 352
Purified caramel and the standardizing of caramel solutions 160
Bernstein, Mitchell. Liquor sodii phosphatus compositus..... 399
Blair, Henry C. Kieselguhr 300
Bogert, Marston Taylor. Classification of carbon compounds.....405, 455
Borneman, John A. Cultivation of medicinal plants..... 546
Brown, Linwood A. Aromatic spirit of ammonia..... 7

Eckler, C. R., and F. A. Miller. A study of American grown cannabis in comparison with samples from various other sources..... 488
Elvove, Elias. Assay of the organic salts of potassium and sodium in the U. S. Pharmacopœia..... 289
Emery, W. O. Volatile acidity of gum tragacanth compared with that of Indian gum 393
England, Joseph W. Sixtieth annual meeting of the American Pharmaceutical Association 512
Weights and measures should be guaranteed U.S.P. standard..... 374

Fuller, H. C. Tragacanth—its sophistication with another gum..... 155

Gold, Walter C. Corundum 61

Hamilton, H. C. The heart tonic unit..... 97
Haskell, C. C. Seasonal variations in the resistance of guinea pigs to poisoning 241
Houseman, Percy A. Constituents of licorice root and licorice extract 531

Kebler, L. F. Report on medicinal plants and drugs..... 499
Kline, C. Mahlon. The 37th annual convention of the National Wholesale Druggists' Association 24
Kraemer, Henry. Biographical sketch of Florence Yaple..... 481
Medullary ray cells in rhamnus purshianus..... 385

La Wall, Charles H. Thalleioquin test..... 484
Lee, Wm. E. Thirteenth annual convention of the N.A.R.D..... 34
Lowe, Clement B. Shorter hours for pharmacists..... 125

Mayer, Joseph L. Quantitative method for the estimation of chloroform in chloroform liniment 372
McIntyre, Ewen. Early days of American Pharmaceutical Association.. 262
Meader, J. W., F. A. Miller and. Alkaloidal content of individual plants of datura stramonium and datura tatula..... 446
Michelson, A. A. Recent progress in spectroscopic methods..... 64
Miller, Adolph W. Mythology of trees 189

Miller, F. A., and J. W. Meader. Alkaloidal content of individual plants of datura stramonium and datura tatula 446
Miller, F. A., C. R. Eckler and. A study of American grown cannabis in comparison with samples from various other sources 488
Minor, R., J. R. Rippetoe and. Colocynth 196
Examination of anhydrous alcohol and ether extracts and ash of same drugs 433
Moore, Charles Watson. Constituents of gelsemium 305
Munroe, Henry S. Physiological effects of carbon monoxide 401

Newcomb, E. L. Digitalis 201

Power, Frederick B. Constituents of some cucurbitaceous plants 145
Power, Frederick B., and Arthur H. Salway. Chemical examination of the bark of erythrophloeum guineense 337
Puckner, W. A. The naming of carbon compounds 104, 167

Remington, Joseph P. Progress of the Revision of the U. S. Pharmacopœia 450
Rippetoe, J. R., and R. Minor. Colocynth 196
Examination of anhydrous alcohol and ether extracts and ash of some drugs 433
and N. Smith. Examination of 47 samples of olive oil 158
Rosengarten, George D. Determination of specific gravity of ethyl ether, U.S.P. 398

Salway, Arthur Henry. The alkaloidal assay of calabar beans 49
Salway, Arthur H., Frederick B. Power and. Chemical examination of the bark of erythrophloeum guineense 337
Sayre, L. E. A problem in the assay of fluidextract of gelsemium 193
Schaefer, George L. Comments on ethyl-morphine and ethyl-morphine hydrochloride (dionin) 389
Sechler, H. M., and M. Becker. Detection of gum ammoniacum and gum galbanum in asafetida 4
Sindall, Harry E. Commercial cinnamon and cassia 496
Smith, N., J. R. Rippetoe and. Examination of 47 samples of olive oil .. 158
Stewart, F. E. Some points in relation to medical and pharmacal legislation 214
Stingel, J. L. Cultivation of hydrastis 299

Taylor, H. L. European requirements for admission to the practice of pharmacology as exemplified in Germany 54
Thum, John K. Abstracts of papers read at the 49th meeting of the British Pharmaceutical Congress 469
Abstracts of State Pharmaceutical Association Papers 35
A note on the proposed formula for petrox 119
Note on tinctura cardamomi composita 298

Vanderkleed, Charles E. Variation in the susceptibility of the guinea pig to the heart tonic group 14

Warren, L. E. A note on the poisonous properties of parthenocissus quinquefolia 51
Watson, Herbert J. Lime water 370
Wilbert, M. I. Biographical sketch of Walter Wyman 1
Eighth International Congress of Applied Chemistry 462
International Congress on Hygiene and Demography 508
Progress in pharmacy 130, 265, 413, 554
The need for further restricting the sale of poisons and habit-forming drugs 302

Young, W. Y. Notes on botany of medicinal plants 256

SUBJECTS.

Acacia seeds, oil of 419
Academy of Natural Sciences of Philadelphia, Centenary of 288
Acid, Acetylcresotinic 417
Acetylsalicylic 559
Salicylic, Toxicity of natural and synthetic 135
Admission to practice of pharmacology, European requirements for (Taylor) 54
Adrenalin 269
Adulteration, Prevention of 28
Agar-agar 417
Alcohol, Antiseptic properties of 558
as a disinfectant 417
glycerin 559
and insanity 270
methyl 270
Alendrin 560
Alkaloidal reactions 268
Allantoin 560
American Medical Association, Meeting of 334
Reports of the chemical laboratory of the 425
American Pharmaceutical Association, Early days of (McIntyre) 262
Sixtieth annual meeting of (England) 512
Ammonium salts 269
Ampelopsis quinquefolia, Note on the poisonous properties of (Warren) 51
Amphotropin 417
Analysis, Methods of 500
Angustura bark tree (Young) 256
Antikamnia 560
Antinarcotic legislation 266
Antiseptic, Alcohol as 417
Antiseptics 417
Apiol 560
Arsenic test, B. P. 417
Asafetida 560
and allied products, A study of the lead number of 505
Detection of gum ammoniacum and gum galbanum in (Sechler and Becker) 4
Further data in regard to 474
Powdered 29
Ash of some drugs (Rippetoe and Minor) 433
Aspidium, Adulteration of extract 136
Aspirin 271
Soluble 418
Australasian Pharmaceutical Formulary, 1911 131

Beeswax 269
Bismuth carbonas, Determination of nitrates in 476
paste 271
Bland's mass, Powdered 39
Board of Food and Drug Inspection, Proposed ruling of 133
Board of Pennsylvania, State pharmaceutical examining 480
Borax 135
British Pharmaceutical Conference 413, 469
British Pharmaceutical Congress, Abstract of papers read at the 49th meeting of the (Thum) 469
Brucine in strychnine, Test for 473
Bryonia, Constituents of (Power) 153
Buchu leaves, Source of (Young) 259

Bufagin 560
Bureau of Chemistry ruling 132

Calabar beans, Alkaloidal assay of (Salway) 49
Chemical constituents of 136
Calcium glycerophosphate, Commercial 418
Poor quality of 560
Calcium lactate 472
phenolsulphonate, Nature of commercial 561
Camphor 418, 561
Determination of 40, 504
Poisoning by 561
trade, Chinese 77
Utilization of leaves as source 271
Cannabis, American grown, in comparison with samples from various other sources (Echler and Miller) 488
Cannabis Indica 561
An essay on 429
Capsule cleaner 144
Carbon compounds, Classification of (Bogert) 405, 455
Naming of (Puckner) 104, 167
Carbon monoxide, Physiological effects of (Munroe) 401
Caramel, purified, and the standardizing of caramel solutions (Beringer) 160
Caspari, Jr., Prof. Chas. Presentation to 96
Chavosol 561
Chineonal 418
Chloroform, Estimation in chloroform liniment (Mayer) 372
Cinchona 561
Cinnamon and cassia, Commercial (Sindall) 496
Cinnamomum Litsea, Oil from 473
Cocaine 561
Identification of small quantities 268
Codeonal 271, 418
Coffee 562
College of Pharmacy, An early 555
Colocynth, Constituents of (Power) 146
Standards for (Rippetoe and Minor) 196
Confectionery, Report on cheap 271
Confections, Detection and estimation of talc in some forms of 38
Convallaria heart tonic unit (Hamilton) 99
Corundum (Gold) 61
Council on Pharmacy and Chemistry of A.M.A. 220, 556
Cucurbitaceous plants, Constituents of some (Power) 145
Cudbear as a pharmaceutical coloring (Beringer) 352
Cultivation of medicinal plants 30
(Borneman) 546
Suggestions for the more extended 470

Datura stramonium and D. tatula, Alkaloidal content of individual plants of 446
Diastase preparations 271
Digest of comments 267
Digitalis 562
Cultivation of (Newcomb) 201
hairs, Variation in the form of 35
Heart tonic unit (Hamilton) 99
leaves, Activity of, and stability and standardization of tinctures 472
New glucosides in 271
Dionin (Schaefer) 389
Dioradin 562
treatment of tuberculous affections 418

Doses 135
Drug therapy 556
Drugs we need 556
Dyewoods and dyewood extracts 86

Echinacea, Fluidextract 38
Pharmacognosy of 37
Education, Pharmaceutical 414, 555
(Taylor) 54
Elaterium, Constituents of (Power) 146
Elixir acetanilid compound 39
Ergot 271
Erythrophlœum guineense, Chemical examination of the bark (Power and Salway) 337
Ether, ethyl, Determination of specific gravity of (Rosengarten) 398
Ethyl and methyl alcohols, Comparison of values obtained for the refractive indices of aqueous solutions of 507
Ethyl-morphine (Schaefer) 389
hydrochloride (Schaefer) 389
Eucalyptus, Critical revision of genus 426
Extract, Fluid of echinacea 38
licorice, Constituents of (Houseman) .....
male fern, Adulteration of 136
Extracts, alcohol and ether extracts in some drugs (Rippetoe and Minor) 433

Fagol 419
Federation Internationale Pharmaceutique 94
Flavoring purposes, Commercial esters used for 475
Fluidextract of gelsemium, A problem in the assay of (Sayre) 193
Formaldehyde, Is it produced upon heating sugar? 37
Formicin 271
Frogs, How far variations in, can be obviated by the use of ouabain (Baker) 247
Fuchsin 272

Gelsemium, Constituents of (Moore) 305
Germany, European requirements for admission to practice of pharmacology as exemplified in (Taylor) 54
German Pharmacopœia .....
Glycerin, Purity of 268
Granular effervescent salts (Remington) 142
Guinea pigs, Seasonal variations in the resistance of, to poisoning (Haskell) 241
susceptibility to the heart tonic group (Vanderkleed) 14
Gum tragacanth, Volatile acids of, compared with that of Indian gum (Emery) 393

Habit-forming drugs, Need for further restricting sale of (Wilbert) 302
Hasheesh, An essay on 429
Headache mixtures, Report on 503
Remedials 38
Heart tonic unit (Hamilton) 97
group, Variation in the susceptibility of the guinea pig to the (Vanderkleed) 14
Hediosit 419
Hexal 562
Hexamethylenamine 272
Hydrastis, Cultivation of (Stingel) 299
Hydrogen dioxide solutions 268
Hydroquinine hydrochloride 419
Hyperol 419

Ichthyol tests 530
Imported drugs (La Wall) 191
Indian gum, Volatile acidity of gum tragacanth compared with that of (Emery) 393
International Congress of Applied Chemistry, Eighth, Account of (Wilbert) 462
Eighth 414
International Congress of Pharmacy 555
International Congress on Hygiene and Demography (Wilbert) 308
International Pharmaceutical Congress 416
International Pharmaceutical Federation 555
International standards 267, 416, 465
Iodo-casein 272
Iridin 419
Isotophan 420

Journal of A. Ph. A. 130

Keratin, Poor quality of commercial 562
Kieselguhr (Blair) 300

Lawang, An oil from 472
Lead in chemicals, Determination of 473
Legislation, Antinarcotic 266
Pharmaceutical 554
proposed in Pennsylvania 284
Some points in relation to medical and pharmacal (Stewart) 214
Uniformity in 32
Licorice root and licorice extract, Constituents of (Houseman) 531
Lime Water (Watson) 370
Liniment, chloroform, Estimation of chloroform in (Mayer) 372
Liquor sodii phosphatus compositus (Bernstein) 399
Literature, Pharmaceutical 415
Logwood 87
Luminal 419

Magnesium peroxide, Degree of purity of 562
Male fern, Adulteration of extract 136
Measures, Weights and 416
Report of Committee of A. Ph. A. 381
should be guaranteed U. S. P. standard (England) 374
Measuring faucet (Remington) 142
Medicated soft drinks 502
Medicinal herbs, American 268
Medicinal plant cultivation 558
Medicinal plants, Notes on botany of (Young) 256
Medicines, Use of 556
Melubrin 421
Mentha piperita 563
Menthol 563
Merjodin 563
Messina essences, Report on market conditions for 223
Methyl alcohol 134
Methyoxymethyl-santalol 275
Metric weights and measures 416
Milk, Artificial 560
Missouri Botanical Garden, William Trelease and the 383
Molybdic trioxide 269
Morphin estimation 505, 506

Narcophine 419
National Association of Retail Druggists, The 13th Annual Convention (Lee) 34
National Formulary 266
Some of the proposed changes 143
National Wholesale Druggists' Association, The 37th Annual Convention of the (Kline) 24
Neosalvarsan 429
New remedies 415, 557
Nitroglycerin in tablets, Estimating 505
Noviform 273

Obituaries:
Dohme, Charles E. (Kraemer) 47
Muir, William (Kraemer) 48
Parrish, Clemmons (Parrish) 230
Wyman, Walter (Wilbert) 1, 47
Yaple, Florence (Kraemer) 481
Oil of ammoniacum, Note on 474
artemisia coerulescens 41
bergamot, Report on market conditions 223
bitter orange, Report on market conditions 223
cardamom root 41
cedar wood, East African 43
cinnamomum burmanii 44
cod liver 269
East Indian bark 472
elemi, Note on 474
galbanum, Note on 474
gum turpentine 319
lemon, Report on market conditions 223
linseed 419
mandarin, Report on market conditions 223
Matricaria discoidea 44
Meriandra benghalensis 45
olive, Examination of 47 samples (Rippetoe and Smith) 158
santolina 46
Satureja cuneifolia 46
sweet orange, Report on market conditions 223
turpentine, Recent studies on 317
wood turpentine 319
Oils, Iodine value of 269
Ointment bases 420
Opium 273
conference 273
conference, International 132
Orcin 352
Organic salts of potassium and sodium in the U. S. Pharmacopœia (Elvove) 289

Paratophan 420
Paregoric, History of 136
Parthenocissus quinquefolia, Note on the poisonous properties of (Warren) 51
Patent medicines 416, 557
Pellidol 420
Pepo, Constituents of (Power) 151
Pepsin in liquids, Determination of small quantities 504
preparations of N.F. 39
seldom presented in England 273

Perfumery, Commercial esters used in 475
Petrolatum saponatum liquidum (Thum) 119
Petrox, Proposed formula for (Thum) 119
Pharmaceutical apparatus (Remington) 142
Pharmaceutical Association papers, Abstracts of (Thum) 35
Pharmacology and Therapeutics of the A.M.A. 131
Pharmacopœia, British 134
extra 415
German V 266, 558
Japan III 267
U. S. Progress of the Revision of (Remington) 450
Revision of 414
Phenacetin, Sulphonal and trional 273

PHILADELPHIA COLLEGE OF PHARMACY:
Annual meeting 232
Commencement, 91st 276
Election of recorder of pharmaceutical meetings 284
Minutes of Board of Trustees 90, 239, 379, 529
Report of Committee on Pharmaceutical Meetings 235
Report of Committee on Publication 235
Report of Curator 237
Report of Editor 236
Report of Librarian 237
Minutes of Pharmaceutical meetings 93, 142, 189, 283
Report of President 232
Minutes of quarterly meeting 88, 376
Physician and drug standards 415
Physostigma, Alkaloidal assay of (Salway) 49
Chemical constituents of 136
Pinus halepensis 319
longifolia 319
Plant defenses, Poisons and 430
Poisons and plant defenses 430
and suicide 89
Sale of, need for further restricting sale of (Wilbert) 302
Post-graduate instruction 135
Potassium, Organic salts of, on the assay of (Elvove) 289
Proferrin 274
Progress in pharmacy (Wilbert) 130, 265, 413, 554
Propaesin 136
Proprietary medicines 557
Proteins for pharmaceutical use, Suitability of various commercial 470
Pseudotsuga Douglasii 319
Public Health and Marine-Hospital Service of the U. S. 267, 423
Report of Surgeon-General 423
Pumpkin seed, Constituents of (Power) 151
Pure Food and Drug Law 265
Pyramidon 563

Quassia, medullary ray-cells in (Kraemer) 385
Quinine, Importation of 274
tannate, Quality of commercial 564
Use of 563

Rabies virus, Preservation of 420
Raphides as plant defenses 432
Remington, Joseph P. Dinner on 65th birthday 192
Pharmaceutical apparatus 142

REVIEWS, BOOK:
Allen's commercial organic analysis 329
Analytical report of Smith, Kline & French Co. 96
Balfour, Andrew. Fourth report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum 138
Base, Daniel. Elements of vegetable histology. British Pharmaceutical Codes 83, 329
Clowes, Frank, and J. Bernard Coleman. Quantitative chemical analysis 137
Coleman, J. Bernard. Frank Clowes and. Quantitative chemical analysis 137
Formulæ Magistrales germanicæ 423
Hale, Worth. The influence of certain drugs upon the toxicity of acetanilid and antipyrine 85
Hampshire, Charles H. Volumetric analysis 421
Heckel, Edward. Annales du Musée Colonial de Marseille 427
Lewin, L. Formulæ Magistrales germanicæ 423
MacEwan, Peter. The Art of Dispensing 331
Marden, J. H. Critical Revision of the Genus Eucalyptus 426
Merck's Annual Report 96
Motter, Murray G., and W. I. Wilbert. Digest of Comments on the U. S. Pharmacopœia and N.F. 333
O'Connor, Charles. Treatise on commercial pharmacy 422
Public Health and Marine-Hospital Service of the U. S., Report of Surgeon-General 423
Puckner, W. A. Reports of the Chemical Laboratory of the American Medical Association 425
Robinson, Victor. An essay on Hasheesh 429
Sadtler, Samuel P. Industrial organic chemistry 327
Schneider, Albert. Pharmaceutical Bacteriology 144
Sherman, Henry C. Methods of Organic Analysis 333
Smith, Erwin F. Bacteria in Relation to Plant Diseases 80
Stone, Witmer. The plants of Southern New Jersey. Sturmer, Julius W. Rudiments of Latin 330
The Chemist's Dictionary of Synonymous and Trade Names 429
Thoms, H. Arbeiten aus dem Pharmazeutischen Institut der Universität Berlin 141
Tschirch, A. Handbuch der Pharmakognosie 330
Wakeman, Nellie. Plant Chemistry for Pharmacy Students 427
Wellcome tropical research laboratories 131, 138
Wilbert, M. I., Murray G. Motter and. Digest of Comments on the U. S. Pharmacopœia and N.F. 333
Wood, Jr., Horatio C. Pharmacology and therapeutics for students and practitioners of medicine 428
Rhamnus purshianus, Medullary ray-cells in (Kraemer) 385
Ristin 421
Rubber as it concerns the retail druggist 519

Salvarsan 136
Sampling, Methods of 499
Santalol, Methyoxymethyl 275
Santalyl lactate 274
Santonin 564
Adulteration of 275
Sarsaparilla, Therapeutics of 275
Scarlet Red 136
Shorter hours for pharmacists 93
(Lowe) 125
(Sparks) 121
Sodium benzoate 132
Organic salts of, on the assay of (Elvove) 289

Sodium phenyldimethyl pyrazonamido-methansulphonate 421
Spectroscopic methods, Recent progress in (Michelson)..... 64
Spirit of ammonia, Aromatic (Brown)..... 7
Squill, Heart tonic unit (Hamilton)..... 99
Standards, Drug, physician and 415
Inadequate 501
International 465
Sterilization 558
Storax, Composition of 275
Stramomium, Alkaloidal content (Miller and Meader)..... 446
Strophanthus, Heart tonic unit (Hamilton)..... 99
Strychnine, Test for brucine in..... 473
Sugar? Is formaldehyde produced upon heating 37
Suicide and poisons 89
Sulphonal 273, 274
Sulphur, Development of Louisiana industry 137
Sunday rest and shorter hours of labor for pharmacists (Sparks)..... 121

Talc in some forms of confections, Detection and estimation of..... 38
Tannaphthol 564
Thalleioquin test (La Wall) 484
Thebaine 273
Therapeutic efficiency 265
Therapeutics, Experimental 135
Thyroid glands, Note on Iodine-content..... 475
Tinctura cardomomi composita, Note on (Thum)..... 298
digitalis, Standardization of 472
Tinctures, Concentrated 474, 559
Trademarks 557
Tragacanth 564
Its sophistication with another gum (Fuller)..... 155
Trees, Mythology of (Miller)..... 189
Trelease, William, and the Missouri Botanical Garden 383
Trional 273
Trivalin 421
Tyramine 276

U. S. Pharmacopœia 266
Physicians' interest in 415
Progress of the Revision of (Remington)..... 450
U. S. Public Health Service 555

Vaccination, Antityphoid 271
Veronal, Toxicity of 137, 564
Veronica anthelmintica 276
Virginia creeper, Note on the poisonous properties of (Warren)..... 51

Watermelon seed, Constituents of (Power)..... 152
Weights and measures 416, 559
Report of Committee of A.Ph.A. 381
should be guaranteed U.S.P. standard (England)..... 374
Wellcome Tropical Research Laboratories 131
Wiley, H. W. Resignation as Chief of the Bureau of Chemistry of U. S. Dept. of Agriculture 265
Wiley investigation 132
Wyman, Walter. Biographical sketch of (Wilbert)..... 1

Yaple, Florence. Biographical sketch (Kraemer)..... 481

Zebromal 276, 421
Zinc permanganate, Nature of 564

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CONTENTS.

The Constituents of Licorice Root and of Licorice Extract. Part 1. By Percy A. Houseman, Ph.D., F.I.C. 531

Cultivation of Medicinal Plants. By John A. Borneman, P.D., Lecturer in Pharmacy, Hahnemann Medical College, Phila., Pa. 546

Progress in Pharmacy. A Quarterly Review of Some of the More Interesting Literature Relating to Pharmacy and Materia Medica. By M. I. Wilbert, Ph.M., Washington, D. C. 554

Notes on Elixir Ferri, Quininæ et Strychninæ Phosphatum U. S. P. and an Improved Formula. By W. L. Cliffe, Ph.G., Philadelphia 565

Book Review 566

The Deterioration of Drugs 566

Chemical Examination of Scammony Root and of Scammony 567

Index to Volume 84 of the American Journal of Pharmacy 569

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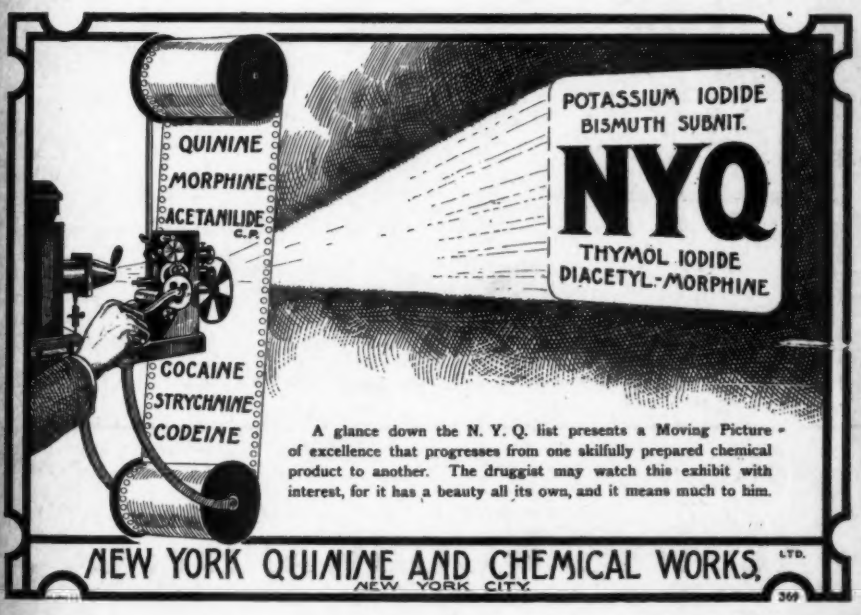
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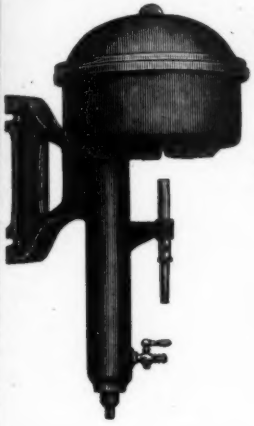

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South Dakota,	E. C. Bent,	Dell Rapids.
Tennessee,	Ira B. Clark,	Nashville.
Texas,	R. H. Walker,	Gonzales.
Utah,	W. H. Dayton,	Salt Lake.
Vermont,	D. F. Davis,	Barre.
Virginia,	T. A. Miller,	Richmond.
Washington,	James, Lee,	Seattle.
West Virginia,	A. Walker,	Sutton.
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The Mulford Bacterins

The Mulford Bacterins (Bacterial Vaccines) for **therapeutic use** are supplied in packages containing **4** aseptic, glass syringes, ready for immediate use, labeled A, B, C and D, respectively.

The number of killed bacteria contained in syringe B is double the contents of syringe A; syringe C is double the contents of syringe B; syringe D is double the contents of syringe C.

Each syringe is graduated into fifths, so that any divided dose of the contained bacterin may be instantly measured.

THE MULFORD BACTERIN SYRINGE

LIST OF BACTERINS

(Bacterial Vaccines)

Acne Bacterin (Acne Vaccine) in 4 syringes. A contains 25, B 50, C 100, D 200 million killed bacteria.

Coli Bacterin (B. Coli Vaccine) in 4 syringes. A contains 50, B 100, C 200, D 400 million killed bacteria.

Influenza Bacterin (Influenza Vaccine Mixed) See price-list for bacterial contents.

Neisser Bacterin (Gonococcic Vaccine) in 4 syringes. A contains 50, B 100, C 200, D 400 million killed bacteria.

Neisser Bacterin Mixed (Gonococcic Vaccine Mixed) See price-list for bacterial contents.

Pneumo-Bacterin (Pneumococcic Vaccine) in 4 syringes. A contains 50, B 100, C 200, D 400 million killed bacteria.

Pneumo-Bacterin Mixed (Pneumococcic Vaccine Mixed) See price-list for bacterial contents.

Scarlatina Bacterin (Scarlet Fever Vaccine) in 4 syringes. A contains 50, B 100, C 200, D 400 million killed bacteria.

Staphylo-Bacterin (Staphylococcic Vaccine) in 4 syringes. A contains 250, B 500, C 1000, D 2000 million killed bacteria.

Staphylo-Bacterin Mixed (Staphylococcic Vaccine Mixed) See price-list for bacterial contents.

Staphylo-Acne Bacterin (Staphylo-Acne Vaccine) See price-list for bacterial contents.

Staphylo-Albus Bacterin (Staphylo-Albus Vaccine) in 4 syringes. A contains 250, B 500, C 1000, D 2000 million killed bacteria.

Staphylo-Aureus Bacterin (Staphylo-Aureus Vaccine) in 4 syringes. A contains 250, B 500, C 1000, D 2000 million killed bacteria.

Staphylo-Strepto-Bacterin Mixed. See price-list for bacterial contents.

Strepto-Bacterin (Streptococcic Vaccine) in 4 syringes. A contains 50, B 100, C 200, D 400 million killed bacteria.

Typho-Bacterin (Typhoid Vaccine) in 4 syringes. A contains 125, B 250, C 500, D 1000 million killed bacteria.

PRICE.—Therapeutic package, 4 syringes (A, B, C and D) to each pkg. $2.00
Single "D" syringes of any Bacterin 50

Mulford Bacterins (Bacterial Vaccines) for **immunizing** or **prophylactic** use are supplied in packages containing **3** aseptic, glass syringes.

Cholera Bacterin (Cholera Vaccine) in 3 syringes containing 500, 1000, 1000 million killed spirilla.

Meningo-Bacterin (Meningococcus Vaccine) in 3 syringes containing 500, 1000, 1000 million killed bacteria.

Scarlatina Bacterin, immunizing, (Scarlet Fever Vaccine) in 3 syringes containing 250, 500, 1000 million killed streptococci.

Typho-Bacterin, immunizing, (Typhoid Vaccine) in 3 syringes containing 500, 1000, 1000 million killed bacteria.

Typho-Bacterin Mixed (Typhoid Vaccine Mixed). See price-list for bacterial contents.

PRICE.—For Immunizing and Prophylactic Use (3 syringes to pkg.) $1.50

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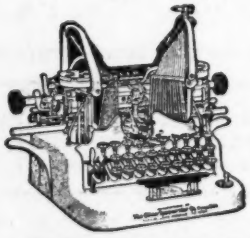

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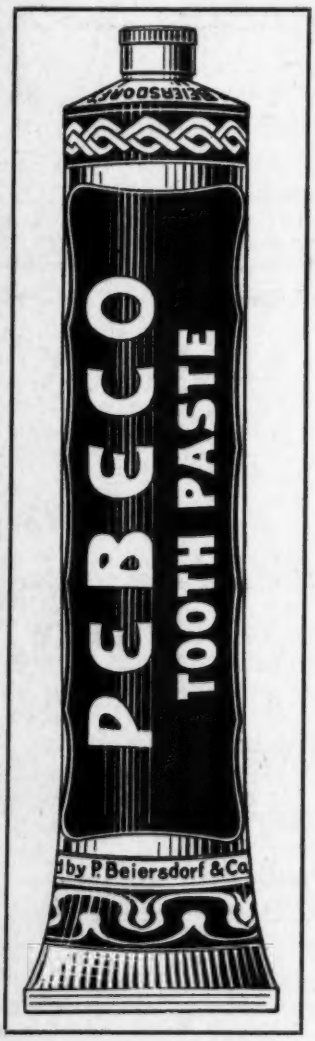

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